

Countermeasures Against Prescription and Over-the-Counter Drug-Impaired Driving

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Title

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Foreword

Driving under the influence of potentially impairing drugs has become a significant traffic safety concern. However, compared with alcohol, relatively little is known regarding the impact of other drugs and prescription and over-the-counter (OTC) drugs in particular on traffic safety, and about effective countermeasures. This is an area where additional research is required and these needs are underscored by the prevalence of drivers testing positive for these drugs.

This report used several methods to gather the current state of knowledge on countermeasures against prescription and OTC drug-impaired driving. The outcomes describe countermeasures related in four categories: pharmacy and medical; data recording and toxicology; law enforcement and judicial; and education and advertising. This report should be a useful resource for researchers, traffic safety advocates and practitioners.

C. Y. David Yang, Ph.D.

Executive Director
AAA Foundation for Traffic Safety

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Numerous subject matter experts shared their leading-edge expertise with the research team. These experts represented a variety of professional domains and organizations. Their insights were particularly helpful for addressing the many gaps in the existing literature and identifying future countermeasures that could be implemented and evaluated. We are so grateful for the help of these experts.

About the Sponsor

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List of Abbreviations and Acronyms

AAAFTS	AAA Foundation for Traffic Safety
ARIDE	Advanced Roadside Impaired Driving Enforcement
BAC	Blood alcohol concentration
BTC	Behind-the-counter
CNS	Central nervous system
DEC	Drug Evaluation and Classification
DMV	Department of Motor Vehicles
DRE	Drug Recognition Expert
DRUID	Driving Under the Influence of Drugs, Alcohol and Medicines
DUI	Driving Under the Influence
DWI	Driving While Impaired
ELISA	Enzyme linked immunosorbent assay
FAA	Federal Aviation Administration
FARS	Fatality Analysis Reporting System
FDA	Food and Drug Administration
HGN	Horizontal Gaze Nystagmus
IACP	International Association of Chiefs of Police
ICADTS	International Council on Alcohol, Drugs and Traffic Safety
NHTSA	National Highway Traffic Safety Administration
NRS	National Roadside Survey
NSC	National Safety Council
OLS	One Leg Stand
OTC	Over-the-counter
PDMP	Prescription drug monitoring programs
SFST	Standard Field Sobriety Testing
SWGTOX	Scientific Working Group on Forensic Toxicology
THC	Delta-9-tetrahydrocannabinol
WAT	Walk and Turn

Executive Summary

Driving under the influence of potentially impairing prescription and over-the-counter (OTC) drugs is a large public health concern. These drugs are used frequently (Centers for Disease Control and Prevention, National Center for Health Statistics, 2016; U.S. Food and Drug Administration, 2017a) and have been shown to impair driving and driving-related psychomotor skills (Couper & Logan, 2014; Gjerde et al., 2015; Strand et al., 2016). In addition, they have shown prevalence estimates of presence in up to 13% of drivers on U.S. roadways (Kelley-Baker et al., 2017). Although there is a significant need for methods to reduce the prevalence of driving under the influence of prescription and OTC drugs, there is currently a lack of research on effective countermeasures to address this problem. Many existing published reviews of countermeasures focus on driving under the influence of alcohol—a very large societal problem to be certain, but also a behavior for which significant research has been conducted. Similarly, many studies focus on impairment by illegal drugs. Based upon differences in etiology, public perceptions, and existing countermeasures, many countermeasures designed for alcohol and illegal drugs may not be effective for prescription and OTC drugs.

This research was designed to fill this gap by assessing the current state of knowledge on countermeasures against prescription and OTC drug-impaired driving. A variety of methods were used to collect data for this effort. These included a comprehensive literature review, an expert roundtable, targeted subject matter expert interviews, and a review of existing data sources. These approaches worked synergistically to identify and evaluate countermeasures against prescription and OTC drug-impaired driving. Countermeasures were classified into the following four categories: (1) pharmacy and medical, (2) data recording and toxicology, (3) law enforcement and judicial, and (4) education and advertising.

A complex search approach was conducted for the literature review using PsycINFO, PsycNET, Compendex, Inspec, National Technical Information Service (NTIS), Web of Science, PubMed, Ovid, and the Transport Research International Documentation (TRID). Professional associations, U.S. government research, and transportation databases from the U.K., the Netherlands, and Germany were also searched. From 16,295 references that were initially collected from this search, in addition to manual targeted searches, more than 200 sources were identified that were relevant to the topic of prescription and OTC drug-impaired driving countermeasures.

The expert roundtable and interviews leveraged the expertise of 17 leading experts from the domains of law enforcement, toxicology, government, law, research, education, medicine, and pharmacy. The expert roundtable was a day-long guided discussion held at AAA Foundation for Traffic Safety headquarters in Washington, D.C. An additional seven individuals were targeted for one-on-one, in-person and telephone interviews. The experts from the roundtable and interviews also consisted of practitioners who could provide direct insight into the implementation of countermeasures. These experts were helpful in identifying unpublished countermeasures, brainstorming novel countermeasures, assessing

the practicality and feasibility of countermeasures, and providing expert-level insight into future directions for countermeasure implementation and development.

A few general findings were evident from the literature review, subject matter experts, and existing data. While a number of countermeasures were identified, there was generally a lack of empirical support and published research on specific ones. One significant challenge is that research is lacking on the specific effects of a number of drugs on driving performance. Furthermore, individual differences in the effects of a given drug make it even more challenging to systematically predict if a given drug or dosage will impair an individual (even more so with polydrug usage). This knowledge is often critical for the effective development and implementation of countermeasures.

It was also identified that while not all prescription and OTC drugs are impairing, drivers may not possess the knowledge necessary to distinguish between impairing and non-impairing medications or the interactions of various medications. Healthcare professionals, law enforcement officers, judicial personnel, and others closely involved with drivers are instrumental in preventing prescription and OTC drug-impaired driving. However, they too may be unaware of the severity of the problem and may lack the resources to address it. Thus, countermeasures should not only be focused on the driver, but also on the numerous other professionals who have an opportunity to intervene with the individual.

The research resulted in the identification of approximately 60 specific countermeasures against prescription and OTC drug-impaired driving. Some areas of particular promise included: patient counseling, prescription labeling, implementation of new technologies (e.g., oral fluid drug testing and electronic pharmacy prompts for impairing medications), increased coordination across the legal system for impaired driving offenses, refinements to existing databases, advertising, education, and increased attention and resources to this important problem.

Introduction and Background

Prescription and over-the-counter (OTC) drug use is highly prevalent in the U.S. Nearly half of Americans report using at least one prescription drug in the past 30 days, 21% report taking two or more prescription medications, and 10% report taking three or more prescription medications (Centers for Disease Control and Prevention, National Center for Health Statistics, 2016). More than 300,000 OTC drugs, which are available without a prescription, are sold throughout American retail stores (U.S. Food and Drug Administration, 2017a).

Despite the prevalence of their use, many Americans are unaware that prescription and OTC medications have the potential to impair driving, though that potential is well documented for a multitude of prescription and OTC drugs. The U.S. Food and Drug Administration (FDA, 2017c) warns of several prescription and OTC drugs that can be dangerous to consume prior to driving, including anti-anxiety drugs, cold remedies, allergy medicines, sleeping pills, pain relievers, and stimulants (e.g., appetite suppressants and some decongestants). Large-scale reviews have documented prescription and OTC drug effects on driving in both epidemiological (Gjerde, Strand, & Mørland, 2015) and experimental (Strand, Gjerde, & Mørland, 2016) studies. Couper and Logan (2014) also reviewed available research, which they integrated with information from drug manufacturers to detail the effects of driving under the influence of several prescription and OTC drugs. Among those drugs were carisoprodol, methadone, dextromethorphan, zopiclone, and diazepam. The effects of these drugs can range widely, from overt psychomotor impairment to subtler psychological symptoms. Poor balance, somnolence, slow reaction times, disorientation, dizziness, fatigue, altered mood, and confusion are just a few of the ways in which drug impairment can manifest while driving.

Unlike alcohol, the effects of prescription and OTC drugs on driving have received significantly less research and public attention. This research gap is particularly evident when examining evidence-based countermeasures. Yet, the usage of prescription and OTC drugs while driving is prevalent and may result in driver impairment. The below sections provide further details regarding the current state of knowledge on prescription and OTC drug-impaired driving.

Prevalence of Drivers Testing Positive for Prescription and OTC Drugs

Estimating the prevalence of drug impaired driving offers many significant challenges. Inconsistencies in drug testing make it challenging to use existing databases (e.g., crash databases) to estimate the prevalence of drugs in traffic outcomes. Additionally, testing “positive” for a drug does not necessarily indicate that a driver was “impaired” at the time he or she was driving. For example, a driver may test positive for a drug that was ingested weeks prior to testing. This is quite different from alcohol, where there is a direct relationship between blood alcohol concentration (BAC) and level of impairment. Thus, drug prevalence numbers cannot be used to directly infer the number of drug “impaired”

drivers and cannot be directly compared to alcohol prevalence. However, drug prevalence can still be a useful metric if these differences are understood.

Considering the widespread availability and use of these drugs, it should come as no surprise that drivers often test positive for prescription and OTC medications. One of the best indicators of drug prevalence is the National Roadside Survey (NRS), which randomly samples drivers from across the U.S. to collect toxicological samples and self-reports of drug use (Kelley-Baker et al., 2017). The most recent NRS demonstrated that 13.0% of daytime drivers and 9.4% of nighttime drivers tested positive for at least one potentially impairing prescription or OTC drug, the most common of which were opioids, antidepressants, stimulants, antihistamines, and benzodiazepines (Kelley-Baker et al., 2017). Figure 1 displays the results of the study stratified by drug or drug class. This figure shows that more than 20% of drivers tested positive for any potentially impairing drug other than alcohol and that drivers often had more than one class of drug present in their system. While the drug most commonly found was marijuana (i.e., delta-9-tetrahydrocannabinol; THC), a number of other drugs were frequently present, including opioids, antidepressants, antihistamines, benzodiazepines, stimulants, and cocaine.

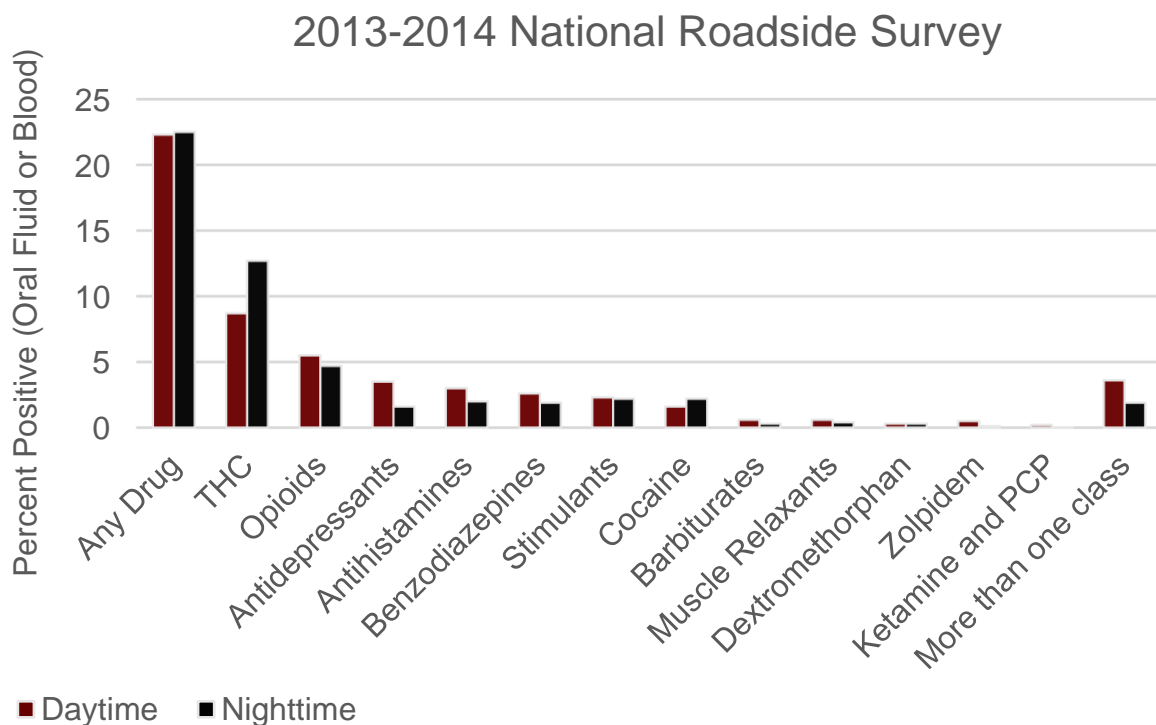


Figure 1. Results of the 2013–2014 NRS (adapted from Kelley-Baker et al., 2017). Categories include those who tested positive for more than one drug. Results outlined in Table 39 of source report.

The European Driving Under the Influence of Drugs, Alcohol and Medicines, or DRUID, project also examined the prevalence of prescription and OTC drugs in drivers, but the drugs tested for varied between countries (Schulze et al., 2012). Although other prescription

drugs were tested in some regions, the main drugs of focus were benzodiazepines, opioids, and Z-drugs (e.g., sleep aids including zopiclone). Examination of these drugs yielded prevalence estimates ranging from 0.17–2.99% across the countries involved. Benzodiazepines were the most commonly detected drugs.

Unfortunately, many studies of drug presence in arrested drivers or those involved in crashes do not distinguish between those individuals who legally used a prescription drug from those who misused or illegally used one. Some studies have shown that prescription and OTC drugs may be more common in arrested drivers and/or drivers involved in crashes than in the general population, but it is necessary to consider that testing positive for prescription drugs in such contexts may be correlated with illegally using or misusing these drugs. One study conducted in Norway found that amphetamine, methamphetamine, and diazepam (a benzodiazepine) were the most commonly found drugs in arrested drivers who tested below the legal limit (0.02 g/dL) for BAC (Bogstrand & Gjerde, 2014). Those above the legal limit were excluded. Like diazepam and amphetamine, methamphetamine is available with a prescription, even though it is often considered an illegal drug. Further, arrested drivers had significantly higher rates of amphetamine and methamphetamine presence compared to control drivers. Thirty percent of arrested drivers who were involved in a crash and 56.9% of those arrested for other reasons tested positive for amphetamine or methamphetamine, compared to only 0.18% of control drivers. A similar relationship was found for diazepam. Nineteen percent of drivers arrested for crash involvement, and 33.5% of drivers arrested for other reasons tested positive for diazepam, compared to only 0.39% of control drivers. These results highlight the magnitude of the impact on the subset of individuals who drive under the influence of potentially impairing prescription and OTC drugs.

While all individuals may be at risk from the impairing effects of prescription and OTC medications, the risk to senior drivers is particularly prominent. A survey of community-dwelling drivers 55 years and older found that 68.7% of respondents used one or more potentially impairing prescription medications and 10.2% currently used five or more potentially impairing prescription medications (MacLennan, Owsley, Rue, & McGwin, 2009). Among the respondents reporting currently taking five or more prescription medications, only 21.9% indicated some awareness of the impairing effects of these medications, and only 18.8% reported receiving a warning about their potentially impairing effects (MacLennan et al., 2009).

Identification of Potentially Impairing Drugs

In response to the wide array of choices available to consumers and the prevalence of prescription and OTC drug use, there are many ongoing efforts to determine the effects of these drugs on individual impairment. While the wide variety of available drugs, drug classes and drug preparations create difficulty in making definitive claims about any particular drug compound, there have been efforts to classify drugs that carry a higher risk of impairment.

The University of San Diego's Training, Research and Education for Driving Safety (TREDS) provides a detailed list of the impairing effects of a number of prescription and OTC drugs, along with recommended alternatives (Hill, 2013). Other lists of potentially impairing drugs are available from the Food and Drug Administration (2017b) and the Federal Aviation Administration (FAA, 2017). The purpose of the FAA's list is to instruct Aviation Medical Examiners which medications they should not issue to pilots without permission from the FAA and the medications that they should advise pilots not to use while flying.

Other resources include fact sheets on various prescription and OTC drugs and their effects on driving (Couper & Logan, 2014) and a recent policy brief summarizing the drug classes that can result in driving impairment (World Health Organization, 2016). The latter resource also notes the specific driving and cognitive processes that are impacted by each drug (e.g., lateral vehicle control, time estimation, balance, mood, etc.). Table 1 combines information from each of the aforementioned sources to display examples of prescription and OTC drugs with the potential to impair the operator of a motor vehicle, organized by drug class. It should be noted that many of these sources are based upon the expert judgment of the organization and/or authors. While scientific evidence and consultation were used by each of these sources, the results are not necessarily derived from specific studies related to the effects of these drugs on crash risk.

Table 1. Potentially impairing drug classes and examples of drugs included in each class. Adapted from Hill (2013), FDA (2017c), FAA (2017), and World Health Organization (2016).

Drug Class	Example Drugs
Stimulants	amphetamine, methamphetamine
Benzodiazepines	alprazolam, diazepam, lorazepam
Opioids	oxycodone, hydrocodone, methadone, codeine
Antidepressants	citalopram, escitalopram, sertraline, fluoxetine, fluvoxamine, atomoxetine
Other CNS depressants (non-benzodiazepine sleep aids, anticonvulsants, muscle relaxants, or barbiturates)	carisoprodol, meprobamate, gabapentin, topiramate, phenobarbital, zopiclone, zolpidem, zaleplon
Antihistamines (OTC)	diphenhydramine, chlorpheniramine
Cough syrup (OTC)	dextromethorphan
Antiemetics	metoclopramide, prochlorperazine
Anticholinergics	atropine/diphenoxylate, benztropine, oxybutynin
Antiparkinsonians	trihexyphenidyl, benztropine, selegiline, rasagiline, ropinirole, pramipexole
Antipsychotics	aripiprazole, clozapine, risperidone, quetiapine
Antidiabetics	insulin, sulfonyleurea, repaglinide, nateglinide
Other medications (impairing due to antihypertensive effects)	acebutolol, atenolol, propranolol, prazosin, terazosin, doxazosin, sildenafil, tadalafil, vardenafil

Unlike tests for alcohol presence, a given concentration of a prescription or OTC drug in bodily fluid is not indicative of the degree of impairment (or even impairment itself) at the time of testing, but rather that consumption of a drug has occurred within a widely ranging time frame. Still, recent drug usage may be the reason for a positive drug test result, which may then translate into an increased crash risk. This could still allow for a negative association between testing positive for a drug and driving performance.

Existing Comprehensive Reviews

Several existing literature reviews and government reports have been published in the broad area of impaired driving, and many have also specifically addressed drug-impaired driving. While relevant and important, prior work has not comprehensively focused on the intersection of the three central topic areas of the present report: (1) prescription and OTC drugs, (2) driving, and (3) countermeasures. As an example, Table 2 displays some prominent reports and reviews in this domain. As demonstrated, the existing research and reviews in this area usually do not primarily focus on countermeasures against prescription and OTC drug-impaired driving. This is a critical gap directly addressed by the research described in this report. Some of these reviews are briefly discussed below. This discussion will highlight the important contributions of these reports and highlight the unique need for the present research.

Table 2. Available literature reviews and relevant areas covered.

Report or Project	Author(s)	Organization(s)	Focused on Prescription /OTC Drugs	Noted Effects on Driving or Crash Risk	Evaluated Counter-measures
Countermeasures That Work	Goodwin	National Highway Traffic Safety Administration		X	X
DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines; several reports)	Schulze, et al. (several others)	European Monitoring Centre for Drugs and Addiction	X	X	X (expert opinion only)
DWI/DUI Interventions	Chodrow & Hora				X
Drug-Impaired Driving: A Guide for What States Can Do	Hedlund	Governor's Highway Safety Association		X	X
IMMORTAL (Impaired Motorists, Methods of Roadside Testing and Assessment for Licensing)	Klemenjak, Braun, Alvarez, Bernhoft, & Fjerdingen	European Commission	(partially)	X	(none relevant to prescription or OTC drugs)
Drugs and Human Performance Fact Sheets	Couper & Logan	National Highway Traffic Safety Administration	X	X	
Driving Under the Influence of Non-Alcohol Drugs – An Update		Division of Forensic Sciences: Norwegian Institute of Public Health			
Part I: Epidemiological Studies	Gjerde, Strand, & Mørland	Division of Forensic Sciences: Norwegian Institute of Public Health	X	X	
Part II: Experimental Studies	Strand, Gjerde, & Mørland	Division of Forensic Sciences: Norwegian Institute of Public Health	X	X	

A leading reference for impaired driving countermeasures is the National Highway Traffic Safety Administration's (NHTSA's) "Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices." This report was first prepared in 2005, and the guide is updated biennially (Goodwin et al., 2015). The goal of the guide is to serve as a reference to help identify effective, science-based traffic safety countermeasures. The guide covers countermeasures on a broad range of topics, including pedestrians, bicycles, motorcycle safety, distracted and drowsy driving, speeding, seat belts, young drivers, older drivers, and alcohol- and drug-impaired driving. Unfortunately, while this report does an impressive job of describing alcohol-impaired driving countermeasures, there is little information on other drugs. In fact, in the most recent 2015 edition, NHTSA notes that it is considering adding sections on drugs other than alcohol in the future to address this concern. This edition has one section containing three drug-related countermeasures: (1) enforcement of drug-impaired driving, (2) drug impaired driving laws, and (3) education regarding medications. Thus, while this document is a valuable resource, there remains a lack of consolidated information on countermeasures specific to prescription and OTC medications.

There are other resources tailored specifically to drug-impaired driving. One notable example is "Drug-Impaired Driving: A Guide for What States Can Do" (Hedlund, 2015). This report was funded by the Governor's Highway Safety Association and the Foundation for Advancing Alcohol Responsibility. It was originally published in 2015, with an update released in 2017, and included an associated toolkit. This report did include countermeasures on drug-impaired driving. However, the report focused broadly on drug-impaired driving as opposed to prescription and OTC drugs. Particular emphasis was placed on marijuana-impaired driving. This focus limited the range of prescription and OTC drug countermeasures discussed.

Another abundant source of data on drugged driving can be found in the European DRUID project (Schulze et al., 2012), which contains data from roadside surveys conducted in 13 European countries, among other projects. This massive effort allowed for drug use prevalence estimates as well as recommendations for countermeasures. While the DRUID project overlapped with the three central focus areas within the present report, it is important to note the countermeasures that emerged were based only upon expert opinions. In addition, prevalence studies varied by region along the drugs that were tested, resulting in a general focus on benzodiazepines, opioids, and z-drugs.

A prior effort to the DRUID project in Europe titled "Impaired Motorists, Methods of Roadside Testing, and Assessment for Licensing" (IMMORTAL; Klemenjak, Braun, Alvarez, Bernhoft, & Fjerdingen, 2005), accomplished similar goals and resulted in recommendations for countermeasures. Countermeasures relevant to the present effort were related to licensing procedures. These countermeasures identified in the DRUID and IMMORTAL projects informed various sections of this report. However, these countermeasures were also based upon prevalence, laws, and other considerations unique to European nations. In addition, countermeasures were based upon expert opinion rather than empirical evaluation. The present report extends beyond these prior studies by

examining empirical research related to the implementation and effectiveness of countermeasures.

As these findings indicate, very few literature reviews or large-scale reports focused on impaired driving have included evaluations of countermeasures against driving while impaired by prescription and OTC drugs. There are some countermeasures in existing literature reviews that show promise in reducing drug-impaired driving and may be applicable to prescription and OTC drug-impaired driving. However, a number of the tactics to prevent driving under the influence of prescription and OTC drugs, which can be viewed as therapeutic, relieving pain or benefiting health, may need to be tailored differently than those related to a substance such as alcohol. All of these factors indicate a strong need to fill the research gap related to prescription and OTC drugged driving countermeasures.

Project Scope and Emphasis

The overall scope of the present research was to identify and evaluate countermeasures against prescription and OTC drug-impaired driving. This approach was designed to address the lack of a comprehensive review and analysis in this domain. The full range of potentially impairing prescription and OTC medications was included in this review. As noted above, alcohol and marijuana were intentionally excluded because of their drug classification and the breadth of existing research. It is also important to consider that drugs are often used in combination. In cases where research, policies, or countermeasures were designed to examine polydrug use with these substances (i.e., alcohol or marijuana), the research was deemed relevant for this project.

The ultimate goal of the project was to consider countermeasures that could reduce the harm from prescription and OTC drug-impaired driving. Yet, a countermeasure did not have to specifically target impaired driving to be included. Indeed, a number of countermeasures could be designed to reduce the abuse of prescription or OTC medications that would likely also lead to a decrease in impaired driving.

The ultimate objective of this report is to provide a comprehensive evaluation of the state of countermeasures against prescription and OTC drug-impaired driving. This objective was accomplished through a literature review, an expert roundtable, and expert interviews. This approach allowed recommendations to be informed by both empirical research and expert insights to arrive at a comprehensive report containing both evidence-based approaches and expert perspectives on countermeasures against prescription and OTC drug-impaired driving. The report documents existing countermeasures, synthesizes evaluations of various countermeasures, and provides recommendations for future research.

Method

This project involved four interconnected data collection efforts: (1) a comprehensive literature review, (2) an expert roundtable, (3) expert interviews, and (4) evaluation of existing data sources. The specific data collection methods are discussed in detail below.

Although the project called on the analysis of existing data sources, those sources have flaws regarding drug use. For example, the data regarding drug use are inconsistently coded in FARS. Additionally, there are vast differences in drug testing protocols between states that severely limit valid comparisons. As discussed in the results section below, several of the identified countermeasures involve correcting these limitations. As a result, the research was unable to collect actual data from existing databases for analysis of the effectiveness of countermeasures for prescription and OTC drug-impaired driving. However, an evaluation of these existing databases was conducted and descriptions of them are provided.

Literature Review

Figure 2 illustrates the process by which articles were chosen for review. The databases used for the literature search were PsycInfo, PsycNET, Compendex, Inspec, National Technical Information Service (NTIS), Web of Science, PubMed, Ovid, and the Transport Research International Documentation (TRID). Professional associations, U.S. government research, and transportation databases from the U.K., the Netherlands, and Germany were also searched.

A complex search approach was used in which multiple keywords were entered within relevant domains (e.g., impairment, transportation, countermeasures), and applicable keywords to those domains were searched using “AND” and “OR” operators to maximize the number of relevant articles found while minimizing irrelevant articles. Appendix A: Search Strategy and Key Terms shows each of the keywords in each relevant domain. Additionally, forward and backward searching was conducted on identified articles that may have been missed in the database searches. This entailed examining the references of articles to identify additional articles related to prescription and OTC drugged driving. This approach ensured the most recently published articles were identified. In addition to peer-reviewed journal articles, this approach also identified “gray literature” such as government reports. Finally, targeted searches on select countermeasures were performed using Google, Google Scholar, and other search engines for additional literature.

All returned articles were stored and processed with EndNote. Each article was reviewed to determine if it included countermeasures for prescription and OTC drug-impaired driving. Literature that was not relevant was excluded from further consideration if countermeasures for prescription and OTC drug-impaired driving were not discussed. Relevant articles were coded into the following categories: (a) government reports, (b) empirical journal articles on countermeasures, (c) non-empirical articles (e.g., literature reviews and websites), and (d) supportive research, which included articles encompassing

three subcategories: drug effects on driving, drug abuse interventions, and prevalence. The first three categories focused on countermeasures against prescription and OTC drug-impaired driving, whereas supportive research comprised potentially relevant research that did not focus on countermeasures. Empirical articles on countermeasures were subdivided into four countermeasure domains: pharmacy/medical, data recording/toxicology, law enforcement/judicial, and education/advertising.

Some of the literature identified during this process was duplicated across multiple reports, journal articles, and/or conference presentations. In other words, the same results were published in different journals or conference proceedings. Typically, priority was given to the peer-reviewed article over technical reports and conference proceedings. However, careful consideration was given to ensure additional information was not included in the technical reports.

The literature search was designed to specifically identify scientific literature from a broad range of databases. However, this approach may have missed non-empirical resources. In particular, countermeasures that had not been empirically evaluated may not have been identified in searching scientific databases. While the primary objective of this effort was to evaluate the current state of countermeasures with formal evaluations, it was also important to comprehensively identify countermeasures that are commonly used but have not been evaluated. A Google search was performed for specific categories of countermeasures for topics within each countermeasure domain to better ensure that all existing countermeasures were identified regardless of their presence in the scientific literature.

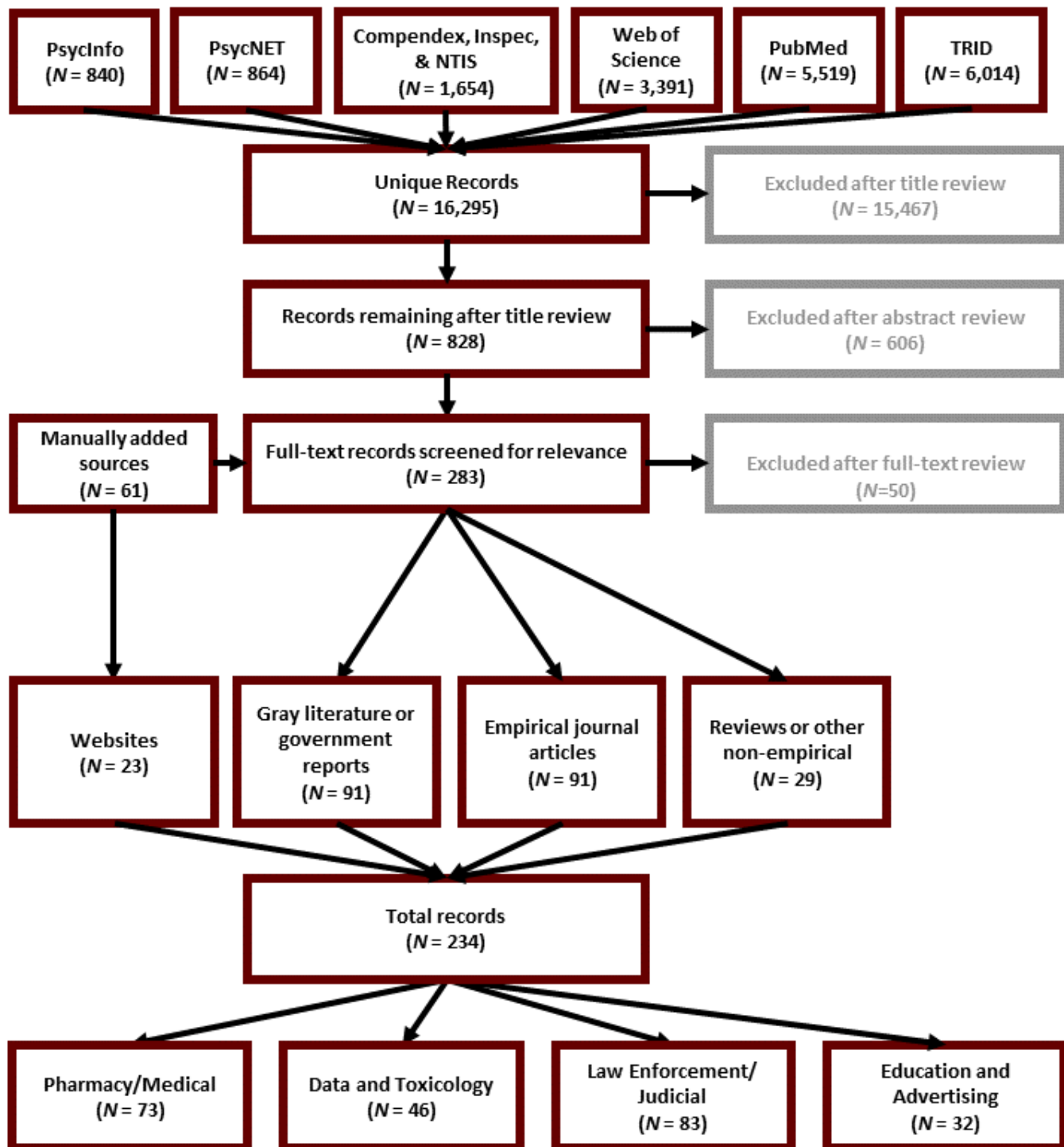


Figure 2. Article selection process.

Expert Roundtable

An expert roundtable was conducted from 9:00 a.m. to 3:30 p.m. on July 11, 2017, at the AAAFTS headquarters in Washington, D.C. The expert roundtable included 10 individuals with expertise in: law enforcement, toxicology, government, law, research, education, medicine, and pharmacy.

The purpose of the roundtable was to complement the literature review by identifying the current state of countermeasures and the development of innovative solutions for reducing the harm from prescription and OTC drug-impaired driving in the U.S. The roundtable discussion was organized around the following categories of countermeasures: pharmacy/medical, data recording and toxicology, law enforcement and court efforts, educational programs and advertising, and additional special concerns for older drivers. Furthermore, the research team facilitated the discussion to include the problem of prescription and OTC drug-impaired driving, existing countermeasures, development and/or adoption of new countermeasures, feasibility, barriers, and cost restraints related to implementation, and other professional experiences on this topic. The agenda for the roundtable discussion can be found in Appendix B: Expert Roundtable Agenda.

The research team facilitated and recorded the discussion around countermeasures. These notes were used for later analysis and reporting of the expert roundtable discussion.

Expert Interviews

In an effort to gather additional opinions on countermeasures against prescription and OTC drug-impaired driving, interviews were conducted with targeted individuals with specialized expertise. Similar to the expert roundtable, the interviewees had expertise in law enforcement, government and public policy, toxicology, judicial practices, medical practices, pharmacy, and commercial motor carrier operations. These individuals were chosen to not only complement the expertise of individuals on the roundtable, but also to gather additional specific information on areas that were identified during the roundtable. All research activities were approved by the Virginia Tech Institutional Review Board.

Expert interviewees were provided several options for sharing their opinions. Due to professional and other constraints, many individuals were only able to informally share their opinions. Participants were also provided the opportunity to speak confidentially (i.e., remain unnamed in any publication or report). From the original list of experts, the following interviewees agreed to participate without a confidentiality request.

Interviews were conducted with the following individuals:

- Richard Compton, Ph.D.: Director, NHTSA's Office of Behavioral Safety Research
- Tom Gianni: Chief, Maryland Highway Safety Office, Maryland Department of Transportation

- Joseph Jones, M.S.: Forensic Toxicologist, PinPoint Testing, LLC. Faculty member, National Judicial College. Adjunct Instructor, Ohio DRE Program.
- Scot Mattox, Esq.: Traffic Safety Resource Prosecutor, Maine
- Mary Pat McKay, M.D.: Chief Medical Officer, National Transportation Safety Board
- DeReece Smither, Ph.D.: Research Psychologist, NHTSA's Office of Behavioral Safety Research

In cases where a participant requested confidentiality, his or her opinions were woven into the report without direct credit and without providing details that could easily link opinions back to the individual or organization.

Semi-structured interviews were conducted by phone. Each interview was conducted by two members of the research team. One interviewer was in charge of leading the interview while the other recorded responses. The principle investigator of the project, Dr. Ryan C. Smith, was involved in each of the interviews. Interviewees were provided with an informed consent document in advance of their scheduled interview, and they provided verbal consent to participate, to be recorded, and to have their names listed in the final report. The interview questions can be found in Appendix C: Expert Interview Questionnaire. Each interview lasted approximately one hour.

Qualitative data analyses and thematic analysis were the primary methods for detailing responses. This was done by considering responses across participants from within each of the four primary content domains: (1) pharmacy/medical, (2) data recording and toxicology, (3) law enforcement and court, and (4) education and advertising. Major themes were gleaned from each of these categories to identify countermeasures, as well as their cost, efficacy, feasibility, and barriers. Participants were also able to freely share their opinions about countermeasures in this area. These comments were integrated into the report and attributed to the specific expert.

Results

Data were primarily collected from the systematic literature review, expert roundtable, and expert interviews. It was deemed that the results of each of these data collection strategies worked best when integrated, rather than when isolated as separate sections. Most often, the findings across these three methods worked synergistically to provide the most thorough description of each countermeasure and current state of knowledge. For example, specific interventions identified in the literature review were also discussed by experts at the roundtable and during interviews. In order to keep the complementary nature of the findings within countermeasure categories, the results section is organized by these categories rather than separated by data collection method.

The data collection yielded four broad categories of countermeasures: (1) pharmacy and medical; (2) data recording and toxicology; (3) law enforcement and judicial; and (4) education and advertising. Accordingly, the results are presented within each of these categories. Findings from each of the data collection methods are discussed within each of these sections. Additionally, recommendations are integrated into each countermeasure section.

One standalone area emerged from the expert roundtable. Experts were asked to provide a quantitative rating of specific countermeasures. Specifically, experts were asked to rate the feasibility and effectiveness of specific countermeasures. An overall rating for each countermeasure was created by multiplying these two numeric ratings. The quantitative findings were integrated into the relevant results sections below, and a table of results is also provided in Appendix D: Expert Roundtable Countermeasure Ratings.

Pharmacy and Medical

The pharmacy and medical communities play an important role in safely prescribing, dispensing, and labeling prescription and OTC drugs. Additionally, the pharmacy and medical communities are the primary providers of patient counseling concerning prescription and OTC drugs. These interventions can be implemented by a number of medical personnel, including doctors, physicians, pharmacists, psychologists, social workers, and occupational therapists.

Prescribing, labeling, and dispensing medication has been the focus of policy efforts for several decades. Current U.S. laws surrounding policies in each of these areas vary by state, so the experience from patient intake to drug dispensing may be different from one individual to another. For example, states may differ on patient counseling laws, requiring counseling for some situations and not others, or for some drugs but not others (Spector & Youdelman, 2010). In addition, 49 states have implemented prescription drug monitoring programs (PDMPs) to track prescriptions of controlled substances, and the last remaining state, Missouri, was in the process of implementing a PDMP at the time of data collection (National Alliance for Model State Drug Laws, 2017). However, programs within each state differ in their specific PDMP regulations. In addition to policy differences, individual

healthcare and pharmacy facilities differ in practices that may also affect drug-impaired driving. The extent to which all of these differences affect the prevalence of prescription and OTC drug-impaired driving is largely understudied. Thus, there is a need to review empirical research on countermeasures against drug-impaired driving that relate to prescribing, labeling, and dispensing medications.

Within the healthcare realm, there are two target time points for interventions to prevent drug-impaired driving: before the individual possesses a given drug, and after the individual has acquired the drug. Both of these time points serve as critical targets of countermeasure implementation. Doctors and pharmacists have the ability to counsel patients about driving risk before the drug is acquired, and there are several techniques that may increase effectiveness of delivering this information. Restricting the prescribing of impairing drugs or increasing their cost compared with non-impairing drugs may sway both doctors and patients to choose safer options. After the patient acquires a potentially impairing drug, labeling practices may play a large role in determining the likelihood of driving under the influence of that drug.

There are a number of critical countermeasures in the pharmacy and medical area that are divided into the following categories: patient counseling, reducing and restricting the prescribing of impairing medications, and prescription labeling. These countermeasures are described in detail below.

Patient Counseling

Patient counseling broadly refers to a patient receiving medical guidance from a trained professional. This includes advising patients about the potentially-impairing effects of drugs on driving performance. This counseling has a wide range of methods of implementation and may take place at doctors' offices, hospitals, or pharmacies. A comprehensive review found that the following methods of patient counseling practices were used at pharmacies: discussing information about a prescription (verbally or in writing); asking a patient if they would like to speak with a pharmacist about their medication; providing any information beyond details related to cost, number of tablets, or number of refills left; and discussing the medical condition itself (Shah & Chewning, 2006). Specific recommendations on counseling procedures that aim to reduce drug-impaired driving were created for pharmacists and physicians by the International Council on Alcohol, Drugs and Traffic Safety (ICADTS) working group, which worked in coordination with the DRUID project. These recommendations included specific advice to pharmacists and physicians on counseling practices. For example, ICADTS discussed situations in which pharmacists should communicate with the prescribing physician. Other recommendations included alerting the patient to the dangers of polypharmacy with psychoactive drugs, and discussing ways to minimize the risk of a traffic crash; recommendations are listed in Appendix E: ICADTS Prescribing and Dispensing Guidelines (Alvarez, de Gier, Mercier-Guyon, & Verstraete, 2007).

The most recent overview of patient counseling laws in the U.S. is listed in the Survey of Pharmacy Law (National Association of Boards of Pharmacy, 2013). Spector & Youdelman

(2010) also provides detailed summaries by state. At the time of the Survey of Pharmacy Law, 43 states, plus Puerto Rico and Guam, had some provisions requiring pharmacist counseling or the verbal offer of counseling all patients. Most state laws specify that this counseling is required for new prescriptions but not refills. Forty-four states also have provisions regarding face-to-face contact with the pharmacist during these interactions, specifying the conditions under which this is required. In some states, patient counseling laws are specific to certain situations, yet as of 2010, only California had a provision requiring written or verbal counseling for medications with the potential to impair driving (Spector & Youdelman, 2010). State counseling policies were enacted in response to the Omnibus Budget Reconciliation Act of 1990, which mandated that an offer of counseling by a pharmacist must be provided to all Medicaid patients. In reaction to the Act, many states chose to enact these provisions for all patients, rather than solely Medicaid recipients (Vivian & Fink III, 2008).

Differences in counseling regulations can drastically affect the quality of counseling that patients receive. In states with lenient laws on the practice, only 43% of patients received verbal counseling from a pharmacist, compared to 94% of patients in states with strict regulations (Svarstad, Bultman, & Mount, 2004). Data from the 2013-2014 National Roadside Survey indicated that between 57.7% and 85.8% of users of potentially impairing prescription drugs reported having received a warning regarding effects of their medication on driving (Pollini et al., 2017). Countermeasures involving patient counseling either aim to increase the use of counseling for impairing medications or to regulate the way in which the counseling is presented. The following countermeasures present methods to increase the availability, frequency, or ease with which counseling is provided to patients who consume potentially impairing drugs.

Revise procedures for drive-through-window transactions involving potentially impairing drugs. Drive-through window transactions for potentially impairing drugs offer unique challenges to patient counseling. Specifically, the drive-through setting may discourage patients from seeking or acquiring valuable information about the impairing effects of their medications. Patients are more likely to accept offers for counseling and spend more time interacting with the pharmacist when at the walk-in window compared to the drive-through (Chui, Halton, & Peng, 2003). Additionally, face-to-face counseling with a pharmacist resulted in better medication compliance in one retrospective cohort study (Taitel, Jiang, Rudkin, Ewing, & Duncan, 2012). This would suggest certain potentially impairing drugs should require a walk-in pick-up rather than a drive-through pickup. Alternatively, drive-through pickups of potentially impairing drugs could be supplemented with driving risk-related information provided via an additional leaflet or verbal contact with a pharmacist.

Integrate prompts into pharmacy software. Some empirical interventions have changed the environment of the pharmacy to prompt pharmacists to offer counseling. This approach may be particularly valuable in the pharmacy environment where time may be limited. For example, Legrand, Boets, Meesmann, & Verstraete (2012) conducted an empirical evaluation of a pharmacy system that integrated prompts with driver-warning information from the DRUID study into existing software. This system allowed pharmacists to view

driver warnings with suggested counseling topics as they dispensed medication. They were also provided the option to print this information out for patients. A test group of pharmacists using this system was compared to a control group of pharmacists who were provided the same information but did not receive automatic prompts as medication was being dispensed. Self-reported pharmacist counseling and knowledge of impairing medications was later assessed. Although results varied on certain questionnaire items, both self-reported counseling and knowledge about driving risks of medications generally showed greater improvement in the group with prompts integrated into their dispensing software. Still, for some drugs, such as paroxetine and diazepam, the majority of pharmacists in the study answered “don’t know” to questions regarding driving risk. Subsequent countermeasures might include both integrated prompts within dispensing software, as well as increased pharmacist education on driving risks of medications.

Use technology to identify drug interactions and alert pharmacists or doctors. These automated prompts also might prove useful when polypharmacy is a concern. For example, software can be programmed to recognize drug interactions and prompt pharmacists to counsel. An overarching theme at the expert roundtable was the lack of potential drug interaction counseling provided by healthcare professionals. Pharmacists and toxicologists present at the roundtable stated that individual differences in patient factors (metabolism, genetics, behavior) prevent completely tailored counseling on potential interactions, but that general information should certainly be provided to patients. Dr. Mary Pat McKay of the National Transportation Safety Board (NTSB) has been involved in investigating transportation crashes. She stated, “We certainly see people who are on four, five, or six impairing medications that may interact.”

Examining the larger snapshot of an individual’s drug regimen, rather than focusing on individual drugs, can prevent patients from experiencing dangerous drug interactions. Synergistic effects can occur when each individual drug alone does not result in significant impairment, but when taken together can be deadly. Benzodiazepines and other sedatives provide one such example (Longo & Johnson, 2000).

Distribute information sheets at patient discharge. Simple interventions at the point of prescribing may influence a patient’s choice to drive. For example, patients may be provided with a predetermined set of facts about their medication and a fact sheet to bring home with them. One such intervention involved counseling patients discharged from the emergency department with an opioid prescription (McCarthy et al., 2015). The intervention group in this study was provided an information sheet on opioid drugs and a research assistant read the information sheet aloud to these patients. Individuals in the control group were discharged without any such counseling. Four to seven days later, patients in the intervention condition were less likely to report having driven a vehicle within six hours of taking their medication (92% of patients in the intervention group, compared to 78.2% in the control group). Interestingly, there was no difference in participants’ recall of being counseled about the dangers of driving after taking their medication between groups. It may be the case that the intervention was effective even though it was not necessarily memorable, or this lack of difference may reflect a limitation of self-reported data. Further, although these interventions seek to increase patient

knowledge of risk, this knowledge does not necessarily predict self-reported driving while taking an impairing medication (Monteiro et al., 2012). If effective, this intervention could generalize across many impairing drugs and would not be restricted solely to opioids. More research is needed to confirm whether these interventions affect drug-impaired driving risk.

Create a new standard for patient intake forms that addresses driving. One recommendation from the expert roundtable was to include questions about driving frequency and importance on physician intake forms. It was noted anecdotally by panelists that questions about driving are often targeted toward teens and older adults, yet physicians may be unaware of the extent to which other age groups who receive impairing medications rely on driving. Asking patients about driving before they are seen by physicians might allow physicians to estimate the severity of risk before prescribing an impairing medication. While no empirical evaluations of the inclusion of driving-related items on patient intake forms were identified, research has shown that standardizing patient documentation forms results in more consistent patient evaluations (Parikh et al., 2007).

Barriers to interventions involving patient counseling. Pharmacists in survey studies have noted several challenges to counseling patients about drug-impaired driving. First, pharmacists have noted a lack of time to adequately explain medication risks to patients. Further, they doubted that patients notice or read warning labels. Finally, individual differences in metabolism and genetics may affect the degree of impairment, which makes creating uniform counseling protocols across all patients very difficult (Jomaa et al., 2018). Pharmacists at the expert roundtable echoed these concerns and also mentioned individual drug differences (half-life, affinity, how the drug is metabolized) that can also preclude a truly tailored intervention. These individual differences can be apparent even within the same drug class.

Another point of concern at the expert roundtable was that pharmacists have a certain level of responsibility to a patient when they are dispensing a drug. The pharmacists present at the roundtable noted that patient counseling and education is a heavily emphasized area during their education and licensure training and is a central part of best practices in the field. However, the pharmacists' largest concern was the difficulty of implementing adequate counseling in a retail setting, where numerous factors work against patient counseling. For example, detailed counseling could increase patient wait times, which would negatively impact customer satisfaction. Pharmacists are encouraged to provide patients with short wait times and friendliness, and consequences exist for individuals who do not meet expectations. These retail interests can interfere with providing patients adequate information about their prescriptions. Finally, pharmacists sometimes take on extra roles in which they provide lengthy counseling and education practices in certain settings (e.g., ambulatory care), for which they cannot always bill. Indeed, research has shown that the busier a pharmacist is, the less likely they are to provide counseling to patients (Svarstad, 2004), and that many pharmacists note a lack of compensation as a barrier to patient counseling (O'Donnell, Brown, & Dastani, 2006).

Reducing and Restricting Access to Impairing Medications

Reducing the number of potentially impairing drugs that are prescribed and used could potentially decrease impaired driving involving these drugs. This could be accomplished by restricting the prescribing of certain drugs (e.g., opioids) or prescribing drugs that have a lower propensity to result in impaired driving. The opioid crisis is of particular concern, as opioids accounted for more than 30,000 overdose deaths in the U.S. in 2015 (National Institute on Drug Abuse, 2017). Efforts to reduce unnecessary opioid prescribing are currently underway. In particular, almost all states have adopted PDMPs to track prescriptions of controlled substances, with opioids as a central focus (National Alliance for Model State Drug Laws, 2017). Some state PDMPs have decreased opioid prescriptions and have already demonstrated effectiveness at reducing drug overdose deaths (Centers for Disease Control and Prevention, 2017), but it is unclear if reducing the number of prescriptions or the dose of the opioid will have an effect on motor vehicle crashes due to drug-impaired driving. As noted in the general overview, although opioids are generally considered impairing, there have been a few conflicting reports on the nature of their effects on driving performance, and results likely depend on individual factors such as dose or length of time that the individual has been taking the drug (i.e., tolerance to impairing effects; Leung, 2011). Because the major treatments for opioid dependence are opioid maintenance therapies, which involve the administration of opioids themselves, it is necessary to consider the effects of these maintenance drugs on driving as well. The benefits of treating opioid dependence with maintenance therapies must therefore be weighed with the possibility that maintenance drugs are impairing (see Strand, Fjeld, Arnestad, & Mørland, 2013, for a review of impairment in patients treated in methadone- and buprenorphine-maintenance programs). Because current research has focused so centrally on opioid drugs, many of the recommendations within this countermeasure domain are specific to these substances. However, opioid drugs are not necessarily the only substances that should be targeted for reductions in prescribing.

Impose restrictions on opioids exceeding 80 mg of morphine equivalence. Regardless of opioids' high abuse potential and impairing effects on driving, many individuals still use chronic opioid therapy (COT) to relieve pain. Hansen et al. (2017) examined more than 30,000 patients in COT using an interrupted time series analysis of three time periods. These time periods reflected important changes to guidelines in opioid prescribing, including dose reduction, physician education, patient education, individualized treatment, modified prescription refill processes, and other initiatives. The changes in guidelines were implemented differentially across treatment settings at these different time points, which allowed a more specific analysis of the interventions that affected motor vehicle crash rates. That is, because interventions were implemented in each of two different healthcare settings after 2008, but only one of these healthcare settings after October 2010, the researchers were able to use different time points within each setting as control groups. No statistically significantly different effects of the opioid-prescribing initiatives were found between any of the patient groups during any of the distinct time periods. There were still no significant differences when controlling for a concurrent sedative or benzodiazepine prescription or when limiting analyses to crashes resulting in serious injury. Still,

regardless of the lack of effect seen for the initiatives, an excess of 80-mg of a morphine-equivalent opioid was associated with an increased risk of a motor vehicle crash overall, relative to individuals who were not using opioids. This study stands as one of the very few studies to empirically examine the effectiveness of a countermeasure to prescription-impaired driving using a non-self-reported dependent measure. The results indicate that restrictions on opioid prescribing may benefit from a cutoff of 80-mg morphine equivalence. This recommendation falls somewhat in line with current Centers for Disease Control recommendations for opioid prescribing, which urge prescribers to use caution past a 50-mg morphine equivalent dose and to avoid prescribing beyond a 90-mg morphine equivalent dose unless there is sufficient justification for an individual patient. (Dowell, Haegerich, & Chou; 2016).

Increase access to opioid maintenance therapy for all prescription opioid users. It is possible that opioid maintenance therapy may decrease crash risk by providing dependent users of opioids with a substitute associated with less psychomotor impairment. In Norway, researchers found that opioid maintenance therapy reduced the likelihood of driving-under-the-influence (DUI) convictions, but these convictions were not specified as drug- or alcohol-related (Bukten, Herskedal, Skurtveit, Bramness, & Clausen, 2013). In addition, the opioid maintenance therapy in this study involved reducing heroin abuse, not prescription opioid use or abuse. Therefore, it is unclear whether the results would generalize to prescription opioids.

Reschedule drugs that have little medicinal value or that have acceptable substitutes available. Several other impairing drugs might be considered for reductions in prescribing (e.g., benzodiazepines, muscle relaxants), but changes in prescribing have received little research attention. One study demonstrated a relation between the withdrawal of the muscle relaxant carisoprodol from the pharmaceutical market and a reduction in DUI cases involving carisoprodol in Norway (Høiseth, Karinen, Sørliid, & Bramness, 2009). Though this result seems intuitive, it is possible that the drug would remain present in the illegal market and prevent reductions in drug-impaired driving. Carisoprodol has been withdrawn from several countries' markets but has remained a Schedule IV drug in the U.S.

Encourage disposal of unused medication with take-back programs. The purpose of medication take-back programs and drug donation boxes is to reduce the number of unused medications that are disposed of improperly. Another central goal is to prevent the acquisition of medications by those to whom they were not prescribed. Thus, these programs may have downstream effects on drug-impaired driving by reducing the availability of drugs to be used and abused. Methods used by take-back programs include holding large community events or installing standing disposal boxes at convenient public locations (e.g., pharmacies). Empirical evaluations of medication take-back programs have shown mixed results. North Carolina's Operation Medicine Drop collected approximately 70 million doses of medication throughout its 1,395 drug take-back events with 245 different law enforcement agencies (Fleming et al., 2016). Another take-back program collected nearly 800,000 doses of medication across seven events (Perry, Shinn, & Stanowich, 2014). Although these programs do result in the return of thousands of unused medications, these medications may represent a relatively small number of those dispensed. For example, an

analysis of Kentucky's efforts found that the proportion of medication collected by take-back programs and disposal boxes represented only 0.3% of that dispensed (Egan, Gregory, Sparks, & Wolfson, 2017). Comparatively, one study estimated the percentage of dispensed medications that are unused to be approximately 42% (Law et al., 2015). Thus, more work is needed to encourage the responsible disposal of medications.

Fleming et al. (2016) noted several barriers to medication take-back programs. The Controlled Substances Act prohibits such take-back events without both law enforcement and a pharmacy technician or pharmacist present. These individuals aid in preventing criminal activity and identifying drugs, respectively. Although this problem can be partially circumvented with permanent disposal boxes, cost remains an issue. Incineration of medications costs approximately \$1.25 per pound, and incinerators must be approved by the Environmental Protection Agency. Other methods can be used but would be dependent on the resources of the surrounding community. Patient knowledge and compliance is also low. One survey found that 50% of patients of an outpatient pharmacy reported keeping unused medication, and less than 25% considered returning their unused medication to the pharmacy. Less than 20% had been counseled on appropriate disposal, though patients who were counseled were more likely to return their medication (Seehusen & Edwards, 2006).

It should be noted that the effectiveness of take-back programs on reducing drug-impaired driving and motor vehicle crashes remains unknown.

Place potentially impairing OTC drugs behind the pharmacy counter. Behind-the-counter (BTC) medications do not require a prescription but do require interaction with a pharmacist prior to purchase. They are placed in a location that consumers cannot freely access. Purchases can be monitored if necessary, as they are with pseudoephedrine (U.S. Food and Drug Administration, 2016). Pseudoephedrine is a decongestant that is also a precursor for methamphetamine and is perhaps the most common example of a BTC drug. This procedure restricts access to potentially impairing drugs and also provides an opportunity for pharmacists to discuss the potential effects of the drug on driving. Changing some OTC medications to BTC may reduce drug-impaired driving under some medications, such as the more impairing first-generation antihistamines. Indeed, this was a suggestion from the expert roundtable. However, empirical research is currently lacking in this area.

Offer employer-insurance-provided alternatives to impairing drugs and treatments for substance abuse. Employers can play a large role in reducing prescription and OTC drug-impaired driving via the benefits they provide to their employees. The National Safety Council (NSC) recently developed a prescription drug employer kit to aid employers in these decisions (NSC, 2017). One recommendation is to provide coverage for non-drug alternatives to pain management, which may sway individuals to choose a non-impairing treatment option. In addition, NSC recommends that employers cover treatments for substance use. Finally, including pharmacy benefit programs in employees' health plans can ensure that certain medications are flagged or require prior authorization approvals before they are dispensed. Each of these efforts has the potential to decrease prescription drug-impaired driving by reducing the number of individuals taking these medications.

Require drug manufacturers to conduct research on the effects of new drugs on driving.

Experts at the roundtable recommended that drug manufacturers thoroughly research the effects of their drugs on driving performance. The FDA recently called for efforts to research drug-impaired driving and provided guidance to pharmaceutical sponsors in particular. They recommended a three-tiered assessment of potential drug effects on driving, with pharmacological/toxicological, epidemiological, and behavioral components. Pharmaceutical companies would benefit from such research. This would allow pharmaceutical companies to develop and market drugs that are at a lower risk of decreasing driving performance, which would be more appealing to customers and insurance companies. Furthermore, it could also reduce liability.

As an expert interviewee, Dr. DeReece Smither, a researcher within NHTSA's Office of Behavioral Safety Research, discussed an ongoing effort to streamline these evaluations of potentially impairing drugs. The effort (FDA, 2017b) assesses prescription, OTC, and illicit drugs using a three-tiered approach. The NTSB, which lists ending impairment in its "Most Wanted" list of transportation safety improvements, was involved in the creation of this effort. The three tiers involve the evaluation and synthesis of pharmaceutical, epidemiological, and behavioral evidence to determine whether there is potential for a given drug to impair driving. Examples of evidence that a drug is potentially impairing may include drug effects such as sedation. If needed, a simulator and on-road test battery would then be devised to evaluate the drug. This process is cost-effective because it eliminates some drugs that are not shown to be high-risk from the more comprehensive test battery. Dr. Smither described this project as "not necessarily a countermeasure, but it's a 'pre-countermeasure,' because it is helping the pharmaceutical industry identify [impairing drugs]." Dr. Smither also expressed that, while pharmaceutical companies should conduct research on the effects of their drugs on driving, standards for doing so are lacking. "There is nothing systematic out there to help them, and this tiered approach is a step in that direction," she commented.

Dr. Smither also noted a new effort to demonstrate the utility and feasibility of the three-tiered approach. In regards to agencies such as the FDA that wish to systematically evaluate drug effects on driving, Dr. Smither stated, "ultimately there is no actual plan for them. There is guidance, but there isn't a path to follow, and we have a new project that began in 2016 that aims to demonstrate this pathway." The project will evaluate two drugs known to impair driving. This project will put these two drugs through the three-tiered approach as a demonstration of how this process would work for new drugs. On the cost of this process, Dr. Richard Compton, the Director of NHTSA's Office of Behavioral Safety Research, noted, "The drug development process can often cost a pharmaceutical company hundreds of millions of dollars to develop new drugs. The testing we recommended in our protocol would be in the noise level considering how much money they spent developing a new drug."

Barriers to countermeasures on reducing and restricting access to impairing medications. The primary barrier in this countermeasure domain is the identification and quantification of the impairing effects of the medications. Without clear knowledge of the impairing effects of different drugs, it can be challenging to not only identify which drugs

are impairing, but also which drugs are less impairing. Individual differences in the effects of drugs may also make it difficult to identify which drugs would be less impairing for a given individual. However, some drugs do have clear alternatives, which have been shown to be equally effective with fewer impairing side effects. For example, second-generation antihistamines such as cetirizine (Zyrtec), fexofenadine (Allegra) and loratadine (Claritin) have less sedating effects than first-generation drugs such as diphenhydramine (Benadryl).

Another challenge beyond knowledge gaps is coordination with multiple large industries. This includes drug manufacturers, insurance companies, employers, and drugstores. Many of these countermeasures rely on cooperation and agreement from these industries, which may have multiple competing financial interests. For example, getting insurance companies to provide better prescription coverage for less impairing drugs requires coordination between employers (and, potentially, unions) and insurance companies. This can take significant time, pressure, and financial resources.

Some drug alternatives also have philosophical and political consequences. For example, opioid maintenance programs are challenged by some individuals because the replacement drugs are still opioids, albeit significantly less harmful for the individual. Thus, countermeasures in this area can face political resistance.

There are also practical barriers to many of these countermeasures. For example, moving OTC drugs behind the counter could necessitate significant changes within stores that sell these drugs. This could include making physical changes to the store to create more space behind the counter and other broad changes to storage and shelving of drugs. It could also have implications for the sale of these drugs at non-pharmacy locations where pharmacists are not on staff to provide the drugs or education.

Prescription Labeling

As noted above and in Jomaa et al. (2018), one concern of pharmacists is that patients do not notice warning labels. One useful countermeasure that has a large body of existing work is in the area of improving prescription labeling to better reflect driving-related risks. This includes making it more clear that the warning applies to driving (e.g., do not operate heavy machinery), making the warning more identifiable, and improving the overall effectiveness of the warning. In a review of the literature on warning labels, Laughery (2006) noted that the process by which warning labels are effective at preventing an undesired behavior includes first noticing and encoding the label, and then complying with the instructions. Some factors that increase the likelihood of the label being noticed include large size, bright color and contrast, a signal word (“danger” seems to be most noticeable), and a related pictogram. Some factors increasing compliance also include pictograms, as well as explicit messages. The same results have also been found in literature reviews of prescription warning labels in particular (Katz, Kripalani, & Weiss, 2006). In terms of large font size, panelists at the expert roundtable were particularly concerned about older adults’ ability to read current U.S. warning labels.

Include a pictogram on prescription labels. Most empirical studies on the effectiveness of prescription labels specifically designed to reduce drug-impaired driving used self-reported

perceptions or intentions as dependent measures. For example, Fierro, Gómez-Talegón, and Alvarez (2013) investigated comprehension of the Spanish warning label, which includes a pictogram of a car inside a red triangle. The majority of participants correctly interpreted the meaning of the warning label (i.e., that the medication may impair driving performance), but some participants incorrectly believed that the label indicated that consumption of the medication should be discontinued or suspended if the individual was planning to drive. Although this study sheds light on perceptions of the warning label, the extent to which these perceptions predict driving behavior under impairing medications is unclear. It is also difficult to determine whether alterations in the label would decrease the number of participants who incorrectly interpreted it. One strategy designed to assist older adults has been to color-code medication labels according to the medical condition that each treated. For example, medications for sleep were given a black label containing sleep-related symbols (sleeping person in bed with “Zzzz”). This technique improved the accuracy of identifying medications, and participants were able to identify their medications from two feet away (Cardarelli et al., 2011).

Include graded levels of risk on prescription labels. Smyth, Sheehan, Siskind, Mercier-Guyon, and Mallaret (2013) compared self-reported intention to drive after viewing either a French or Australian prescription warning label. Both of the labels warned of the risk of driving while taking the prescription, but the French label contained a pictogram of a car and was tailored to the potential level of impairment. The language in each level escalated from “Be careful,” to “Be very careful,” to “Attention, danger: do not drive.” Participants reported more reluctance to drive when they were shown the French label.

Emich, van Dijk, Monteiro, and de Gier (2014) analyzed various self-report metrics, including estimated risk, after participants viewed either the Dutch “yellow-black” label or the rating model label from the DRUID study (Meesmann et al., 2011; Ravera et al., 2012). The yellow-black label roughly translates to “This medicine can reduce reaction time (driving a car, operating machinery) Caution with alcohol!” The DRUID rating model label was designed to indicate one of four categories of risk. This categorization system was created in the DRUID study and ranges from 0 (“presumed to be safe or unlikely to produce an effect on fitness to drive”), to 3 (“likely to produce severe effects on fitness to drive”). The DRUID label includes a pictogram of a car and was presented in two forms: with and without the addition of a small area with text (“side text”) that described the level of caution to be practiced: “Be careful! Read the patient information leaflet before driving.” (category 1); “Be very careful! Don’t drive without the advice of your GP or pharmacist.” (category 2); and “Attention: danger! Do not drive. Seek medical advice before driving again.” (category 3). The yellow-black label contains some of the characteristics noted to increase the effectiveness of warning labels in Laughery (2006), whereas the DRUID label contains the vast majority of these characteristics. Emich et al. (2014) found that the rating model with the side text included resulted in the highest estimated risk by participants. Another study did not show any added value of the side text (Monteiro, Huiskes, Van Dijk, Van Weert, & De Gier, 2013), but did show consistent results in that the rating model from the DRUID study was more effective than the French pictogram model with graded levels of impairment (i.e., the same French label used in Smyth et al., 2013).

Overall, the results of prescription-labeling studies indicate promise for labels that include a pictogram and graded levels of potential risk. The text descriptions may make labels more noticeable and thus may add some effectiveness at preventing drug-impaired driving. In particular, the DRUID label seems to integrate all of these elements and proved to be an effective mode of communication. Panelists at the expert roundtable were in favor of a move toward a DRUID-style label. Pharmacists in Jomaa et al. (2018) suggested that expected duration of impairment could be added to the labels. They also suggested that labels could be tailored to the drug class, rather than placing the same label on all potentially impairing medications. Panelists at the expert roundtable echoed both of these suggestions and added that while patients have some accountability for reading prescription labels, the labels themselves should draw patients' attention to them.

Barriers to changes in prescription labeling. Most of the barriers to prescription labeling relate to the complexity of making broad systemic changes. Companies would need to spend time and resources to update their labeling practices. The inclusion of pictures and color could create a significant burden if current label printing capacities do not allow for these additions. Ultimately, the effectiveness of better labeling also depends on reliable information on the impairing effects of drugs. If the effects of various drugs on driving remain unknown, then labeling practices will also be ineffective.

Data Recording and Toxicology

Tracking the success of countermeasures against prescription and OTC drug-impaired driving requires appropriate data recording and measurement, both at baseline and following interventions. Because the wide array of prescription and OTC drugs have varied pharmacokinetic and pharmacodynamic properties, toxicological detection of drug use is complex. Detection of certain drugs and their metabolites in bodily fluids, particularly urine, often does not indicate impairment by the drug at the time of driving. This can be due to differences in pharmacological properties of drugs, the lack of levels that correlate with impairment for various drugs, or individual differences in drug effects. Also, there is often a significant delay from the time an individual is driving (e.g., following an arrest) to when a biological specimen is collected for drug testing. This may provide sufficient time for a drug to be metabolized out of a driver's system or for concentrations of a drug to significantly decrease.

The psychoactive compound of marijuana, THC, presents one example of a drug which has proven problematic to associate with impairment in drivers. High concentrations of THC can be present with little impairment and vice versa. Thus, even when data are available regarding drug concentrations in drivers, drawing conclusions regarding impairment is often not possible (e.g., Tefft, Arnold, & Grabowski, 2016). Prescription and OTC drugs also present similar challenges, particularly due to the vast number of unique compounds. The degree of ability to associate impairment with concentrations likely varies greatly between compounds, many of which have not been systematically studied in this regard.

In addition to the toxicological challenges noted above, many existing sources of impaired driving data contain other significant limitations. For example, the validity of many

drugged driving prevalence estimates is questionable due to differences in the recording of related variables, such as those related to arrests and crashes (Walsh, 2009). Recording and interpreting DUI data in apprehended drivers is very complex. State differences in drugged-driving laws can influence the type of data recorded by police officers and related personnel. For example, it is possible that, in states with per se laws that have specified limits for drugged driving, quantitative drug level can be quite important, whereas states with zero-tolerance laws may only record whether a drug test is positive or negative. Furthermore, many states have procedures where a drug test is not analyzed if a driver's BAC is over a certain level (e.g., 0.08 g/dL). If drug use is not suspected, then a biological specimen may never even be collected from a driver for later drug testing.

Even fatal crash data is plagued by inconsistencies in drug testing and missing data (Berning & Smither, 2014; Slater, Castle, Logan, & Hingson, 2016). Therefore, efforts to prevent drugged driving are impeded by a lack of valid and consistent methods of measuring both the scope of the problem and the effectiveness of programs designed to reduce it.

Countermeasures that involve data recording and toxicology are closely linked with those in the law enforcement and judicial realm. For the purposes of the present review, data recording and toxicology countermeasures encompass the improvement and/or standardization of the collection and reporting of toxicological drug data and improvements to the quality and access to relevant databases. This focus is distinct from the law enforcement and judicial category (reviewed in the following section), which concerns the effectiveness of laws or other techniques when they are applied. The countermeasures that emerged in the data recording and toxicology domain include a wide variety of efforts including increasing access to databases, ensuring more consistent drug testing and standardizing toxicological practices.

Refine the Fatality Analysis Reporting System (FARS) Database. FARS, which was noted as a source of fatal crash data earlier in this report, contains data from an annual census of fatal traffic crashes in the U.S. and can provide robust analyses regarding crashes involving alcohol-impaired drivers. These analyses are robust due to the ability to impute missing data, an accepted statistical method for handling missing data under certain conditions. Unfortunately, limitations due to missing drug data cannot be overcome in the same way, due to the wide variety of drugs and various state differences in drug testing protocols for fatal crashes. Numerous studies have attempted to extract drugged driving trends using FARS data (e.g., Brady & Li, 2014; Romano & Pollini, 2013), but the limitations often make valid conclusions about drugged driving impossible. Study replications have yielded conclusions that differ widely, even when using the same FARS data (Romano, Torres-Saavedra, Voas, & Lacey, 2017). Slater et al. (2016) and Berning and Smither (2014) have outlined several of FARS' limitations:

- A maximum of three drugs may be entered at once for a given case. For cases with more than three drugs present, a somewhat arbitrary hierarchy of drug class determines the drugs to be entered.

- Only 57% of fatally injured drivers and only 17% of surviving drivers involved in fatal crashes are tested for drugs.
- Neither quantitative drug concentrations nor the length of time from crash to drug test are recorded into FARS, precluding reasonable estimates of impairment. A positive drug test alone does not indicate impairment at the time of driving, especially when urine is used. There are no national standards for determining the type of specimen tested in the event of a fatal crash (i.e., blood, urine, oral fluid, or other specimen).
- Variations in drug-testing panels, cutoffs, and confirmatory testing procedures across laboratories hinder the ability to collapse data across jurisdictions and states.
- Surviving drivers who were deemed at fault in the crash (defined by researchers as incurring a moving violation) are more likely to be tested in comparison to surviving drivers not deemed at fault.
- Laboratories vary in sensitivity and specificity of tests, equipment and procedures used, and training of personnel. Laboratories do not always report results to FARS.
- As a result of many of the above limitations, missing drug data cannot be imputed because data are missing not-at-random; i.e., there are differences in variables associated with obtained cases versus missing cases.
- Even when examining subsets of drivers, studies that use FARS data can result in selection bias (e.g., selecting more severe crashes, more impaired individuals, etc.)

Refining the FARS database is an important strategy to help support countermeasures to prescription and OTC drug-impaired driving. The development of better data in this area will help to better understand the scope of impaired driving (particularly in relation to non-alcohol drugs), garner support and resources for countermeasures, and evaluate the effectiveness of countermeasures. More specifically, each of the limitations noted may themselves represent a separate countermeasure to be addressed. An expert interviewee representing NHTSA communicated that the first limitation (the three-drug maximum) has already been addressed. Beginning in 2018, there will be no maximum limit on the number of drugs that can be entered. Additional efforts to improve FARS are also underway. Until these are completed, researchers should avoid using the dataset to draw conclusions regarding drugged driving.

Increase Access to Databases. Database access is crucial for analyzing the variables that predict drugged driving and for determining the role of drugs in crashes. While the FARS dataset has several limitations, conversations with experts revealed that improvements are underway, so the dataset may eventually be useful for this purpose. Until then, researchers must be able to access drugged driving data from other sources. Experts at the roundtable stressed the importance of this access, as it could increase the quality and quantity of scientific reports on drugged driving by allowing analysis of non-FARS data. NHTSA currently maintains a database of information collected during Drug Recognition Expert (DRE) evaluations (NHTSA, 2017), but the information is highly sensitive and thus not

available to researchers. It is unclear whether it would be feasible to implement de-identification and recoding procedures that would maintain the integrity of the database while allowing scientific analysis by researchers. Experts at the roundtable noted that it is not mandatory for officers to input data to this database and recommended that this policy be changed.

NHTSA has recently made several large-scale databases available from its extensive portfolio of drugged driving research. This includes the 2007 and 2013-2014 National Roadside Survey (NRS), Crash Risk Study, and Washington State roadside data. Indeed, researchers have already merged the 2007 NRS database with FARS data to attempt to gain better estimates of crash risk (Li, Brady, & Chen, 2013; Romano, Torres-Saavedra, Voas, & Lacey, 2014). Despite the added value of the NRS dataset, there continues to be a need for additional data sources for two reasons. First, researchers seeking to replicate, in a new dataset, findings on drugged driving that were derived from an earlier dataset, cannot use the FARS and NRS datasets. These datasets present very different samples, were collected using different methods, and have different limitations. Providing researchers access to sources such as the DRE database would begin to address the lack of available data in this area.

Other sources of data that are not always associated with driving may also be particularly beneficial for analyzing impaired prescription and OTC drugged driving. Experts specifically noted that valuable sources of drugged driving data may be found indirectly via PDMPs and electronic medical records. PDMPs include large databases that track individuals who are prescribed medications that carry significant risk, particularly opioids. Electronic medical records obtained from hospitals would provide similar benefits and could address surviving but injured drivers, who are not always represented in FARS. In particular, data from trauma centers may be useful. This data could ideally be coupled with emergency medical services (EMS) data. Because EMS would record any drugs administered at the scene of a crash, researchers would be able to exclude drugs that were administered by medical personnel and yield better estimates of drug prevalence.

Again, because these sources of data are sensitive and confidential, meticulous de-identification protocols would need to be developed to ensure patients' rights are protected. Increased access to such data would shed light on some of the limitations of previous studies using flawed data. For example, changes in opioid (or other drug) prescribing can be examined alongside drugged driving arrests and crashes to further elucidate the effects of prescription drugs on these variables. While these datasets would inevitably bring new challenges and limitations, examining drugged driving from a new perspective would reduce the reliance on the FARS dataset and broaden the scope of research in the area.

Mandate Drug Testing in All DUI Arrests. For a number of reasons, drug testing may not be conducted in all impaired driving arrests. As a number of the subject matter experts who participated in this research reported, many states have a single offense for both alcohol-impaired and drugged driving. This means the charge and sanction are the same regardless of whether or not a driver was impaired by alcohol, other drugs, or both. Thus, it is common practice in several states to forgo drug testing when an individual's BAC is above 0.08 g/dL,

as positive drug test results will not increase the probability of a conviction since the driver already committed the impaired driving offense by exceeding the legal limit for alcohol. Drug tests can also be costly, complicate the legal case, and ultimately, have no impact on the impaired driving offense or punishment. However, the tendency to forgo drug testing creates a significant gap in the data on drugged driving. Thus, some experts at the roundtable also recommended that drug testing be implemented in all DUI arrests. However, other experts cautioned that an increase in testing may result in the false appearance of an increase of impairment if researchers attempt to compare data longitudinally. Drug testing for all DUI arrests has also been recommended by ICADTS (Walsh, 2002).

Establish Standards of Practice for Forensic Toxicology Laboratories. Forensic toxicology laboratories can greatly aid in collecting quality data on drugged driving. For example, each biological sample from a fatal crash or arrest must be analyzed by a toxicology laboratory prior to entry into FARS or the criminal justice system. However, laboratories can vary in several ways, including equipment, drug cutoff levels for indication of a positive result, standard drug panels, and other factors. There are particular challenges for some prescription and OTC drugs because they may not be commonly used in drug panels, and laboratories may not have developed the necessary standards for their analysis.

One major effort to resolve some of the issues surrounding toxicological drugged-driving data was conducted by the NSC (Logan et al., 2013). Data were gathered from interviews with 96 laboratories that provide testing services for drugged driving cases. Follow-up data were also collected with a smaller sample of participants at a two-day meeting. The result was a comprehensive set of recommendations for standards of practice for toxicological practices surrounding drugged driving, which included the following guidelines for laboratories:

- Analyze drug presence via a tiered system, always performing tests for those drugs that are most prevalent and potentially impairing (comprising Tier 1), regardless of a law enforcement officer's opinion on which drugs were present.
- Standardize scope and cutoffs amongst laboratories. (Specific recommended values were reported across drugs.)
- Offer confirmatory testing for all compounds, and only report results after these analyses are completed. Presumptive positive tests should not be reported due to the wide-ranging implications for judicial outcomes.
- Include detailed information on the scope of testing in the reported results.
- Consider cross-reactivity of drugs within a class when choosing an immunoassay. (Cross-reactivity occurs when one or more drugs' chemical makeup interacts with another drug and masks the true test result.) Cross-reactivity varies amongst kits.
- Follow the Scientific Working Group on Forensic Toxicology (SWGTOX) guidelines for method validation (SWGTOX, 2013).

Barriers to implementation. Included in the data collected by the NSC (Logan et al., 2013) were questions concerning alignment with an earlier version of toxicology guidelines published in 2007 by the NSC and NHTSA (Farrell, Kerrigan & Logan, 2007). Several laboratories reported that they were not following the 2007 recommendations. Participants noted the lack of staffing, necessary instruments, and technology as a few reasons they did not adhere to the guidelines. Others noted that quantitative values were only provided in specified cases. One major roadblock to obtaining quantitative test results concerned the existence of laws in the jurisdiction of some laboratories that do not allow for cost coverage of unscheduled substances. These laws can draw attention away from unscheduled OTC substances that can impair driving, such as first-generation antihistamines.

Expert interviewee and forensic toxicologist Joseph Jones also provided insight into the difficulties involved in implementing changes for standardization, stating, “[Laboratories] physically don’t have either the talent on board (it does take a lot of expertise), but also the instrumentation... The instrumentation costs a lot more and it’s also highly technical. For someone that was trained on one way, it’s hard for them to adapt.” He spoke of the Coverdell National Forensic Science Improvement Grants Program (National Institute of Justice, 2018) as one avenue for laboratory funding that is helpful, but limited. In government laboratories, “for the most part, you’re strictly limited to continuing education through the Paul Coverdell grant.” He described how the grant can often be distributed among dozens of personnel trainings and certifications, creating the need for additional funding from other sources. “As new technology comes about... you’ve got to be able to invest in your people to bring them back up to speed.” Integrating new technologies can include methods such as use of robots to complete tasks. Use of these technologies is important to consider, as they can circumvent the backlog of cases that many laboratories are experiencing. Jones spoke of a successful implementation in Ohio, where he was the Crime Lab Director for the Ohio State Highway Patrol Crime Laboratory, commenting, “We set up testing in Ohio where you’re able to process 15,000 cases with four or five people, and all of that was through investment in technology and people.”

The Logan et al. (2013) guidelines have been in distribution among laboratories and supporting organizations. Because a replication of the survey will not be conducted until 2018, it is unknown whether the updated guidelines will result in a higher degree of compliance.

Determine the Validity of Inferring Impairment from Toxicology Results for Specific Drugs.

Although per se levels for alcohol (0.08 g/dL) reliably detect impairment in individuals, the metabolism of prescription and OTC drugs varies from that of alcohol, creating a need for new techniques and standards to detect these drugs. In addition, the wide variety of prescription and OTC drugs make it difficult to determine the levels that coincide with impairment. Within the same drug class, different drug compounds often carry higher or lower risk for impairment. Even when considering the same compound, drug preparations, such as extended or sustained release capsules, can create variations in drug impairment at similar levels in bodily fluid.

There have been a few attempts to determine drug concentrations that reliably coincide with impairment. Vindenes et al. (2011) proposed concentration limits for three opioids

(buprenorphine, morphine, and methadone), seven benzodiazepines, two z-hypnotics, or sleep aids (zolpidem and zopiclone), and two central stimulants (methamphetamine and amphetamine). Limits were established for several illicit drugs as well. These limits were developed by reviewing experimental studies assessing tests of sedation, drowsiness, divided attention, and other traffic-relevant dependent variables. Quantification of impairment by each drug was based on determining concentration levels that corresponded with similar alcohol impairment at 0.02, 0.05, and 0.12 g/dL BAC. This quantification by level of impairment allowed for the implementation of graded sanctions in Norway for specific concentration limits (listed in Appendix F: Detection Limits Used in Vindenes et al., 2011).

The ability to define such limits may be drug-dependent. For example, Jones (2007) found no relation between amphetamine concentrations in blood and impairment on a variety of cognitive and psychomotor tests. The experience of the evaluator may also play a role in whether impairment is suspected, as some of these tests were somewhat subjective (e.g., the individual's demeanor). In addition, others have reported conflicting results when impairment was a dichotomous variable (i.e., individuals were defined as impaired or not impaired; Gustavsen, Mørland, & Bramness, 2006).

Barriers to implementation. Many experts were concerned with the implications of attempting to use alcohol impairment at different BAC levels as a benchmark for determining levels of prescription and OTC drug impairment. Experts in toxicology, policy, and research noted that the extent of drug tolerance can vary among different drugs and drug classes. In contrast with alcohol, some drugs may only be impairing during the first few days or weeks of use. In addition, drugs present a much larger challenge than alcohol, due to the large number of substances that would need to be systematically examined by comparing impairment with various levels in bodily fluid. These challenges may prevent a fully quantified approach to demonstrating impairment.

Jones, Holmgren & Kugelberg (2007) call attention to the various impediments to inferring impairment from prescription drug concentrations in particular. Drug levels can depend on a host of factors. The dosing regimen (acute or chronic) can interact with the half-life of the drug to produce very different concentrations. The ingestion of food near the time of dosing (if oral), the demographics and weight of the individual, the length of chronic dosing (i.e., tolerance of the individual), and the function of the liver and kidneys are all involved in metabolism of prescription and OTC drugs. The last consideration is particularly important for older adults, as are drug-drug interactions. As Tom Gianni, Chief of the Maryland Highway Safety Office, noted, "I think the biggest challenge to identifying countermeasures is figuring out what the problem is. Where do we need to address the concerns? [Drug-impaired driving] is not like addressing alcohol, which has a consistent set of variables, a consistent set of symptoms [associated with impairment]. We're dealing with a wide spectrum of drugs that affect people differently in different doses, and in different ways. It's just not as simple. Until you know the problem, it's tough to address the symptoms, let alone the cause." Jones et al. (2007) also bring attention to the existence of differing genotypes that can differentiate slow and rapid metabolizers of certain drugs. The authors

note several other drug-specific and person-specific factors and call for a consideration of these factors wherever possible.

Experts in pharmacology and toxicology at the roundtable were also particularly wary of attempts to correlate drug levels with impairment and stressed many of the same concerns. Experts in the legal realm noted that convictions are obtained on the basis of the officer's detection of behavioral impairment and that drug tests are considered a supplement to support these claims rather than evidence on their own. This places an important role on trainings such as ARIDE and the DEC program. Education was proposed by some experts as a way to abate these issues. Such education would relay to individuals that there is a risk of driving impairment with their medication and that they have the responsibility to be cognizant of how their medication may uniquely affect them before driving.

Replace Urine Testing with Oral Fluid Testing when Recent Use is of Interest. The implications of drug test results depend heavily upon the bodily fluid, or matrix, tested. Oral fluid provides an indication of drug use similar to blood. In fact, drug levels in oral fluid from the most recent NRS were compared with drug levels in blood, yielding a 97.2% agreement in positive results, with more than 75% of results constituting exact matches for specific drugs. The sample contained more than 3,000 individuals and the laboratory was blinded as to which samples were paired. Amphetamines and opiates were the prescription drugs analyzed in this study, and amphetamines were easier to detect than opiates. Amphetamines showed both sensitivity and specificity values above 90%, whereas opiates showed low sensitivity (44.40%) but high specificity (99.97%) when validated with blood results (Kelley-Baker, Moore, Lacey, & Yao, 2014).

Levels derived from urine testing tend to be less correlated with those derived from blood compared to oral fluid levels. In urine, both drug and metabolite levels depend heavily on the amount of liquid consumed as well as various metabolic factors. For example, amphetamine concentrations depend upon the urine's acidity (Jones & Karlsson, 2005). Drugs detected in urine have already been present in the body for a longer minimum time frame than they would be in blood. Urine testing for various drugs also relies on detection of the metabolites of a given drug, rather than detection of the parent drug itself. Oral fluid, however, can detect recent use of a drug, because drugs in saliva are diffused directly from blood. Thus, oral fluid drug tests can improve detection of recent prescription and OTC drug use when compared to urine and can reduce the invasiveness of testing that occurs with blood.

Comparison and validation with blood. Although blood is considered the preferred matrix for evidence of drug use, collecting it is an invasive procedure and it is often collected on biased samples. For example, blood is easier to collect in fatal crashes than it is to collect from consenting survey participants who may be wary of needles. Thus, there may be a bias that favors blood collection in more severe situations. Oral fluid tests tend to provide very similar results to blood tests (Kelley-Baker et al., 2014; Wille et al., 2009; Toennes, Steinmeyer, Maurer, Moeller, & Kauert, 2005). Toennes et al. (2005) found 93.1 and 95.4% accuracy for amphetamines and opioids, respectively using the Dräger DrugTest®. Data from the 2007 NRS using the Quantisal® test by Alere Corp. revealed similar results,

supporting the accuracy of oral fluid tests, although this study mainly focused on non-prescription drugs (Kelley-Baker et al., 2014). Although oral fluid has proven to provide similar results to blood tests, it is still recommended that oral fluid test results be confirmed with blood tests (Drummer, 2008).

Van der Linden, Wille, Ramírez-Fernandez, Verstraete, & Samyn (2015) compared drug screening results from two time periods in roadside drug testing using differing procedures in Belgium. Older legislation involved urine sampling, whereas newer legislation involved oral fluid sampling, with confirmation tests in both cases using blood sampling. Fewer false positives were found for amphetamines, oxycodone, codeine, and pholcodine using oral fluid. Other studies have found that oral fluid testing resulted in more positive confirmation tests than urine tests (Logan, Mohr & Talpins, 2014). Using blood as the reference for comparison, Toennes et al. (2005) found that urine and oral fluid were equally accurate overall for amphetamines (though the rate of false positives was higher for urine, and the rate of false negatives was higher for oral fluid). However, oral fluid was more accurate overall for detecting opioids than urine, even though it resulted in a slightly higher number of false negatives. In addition, oral fluid tests perform particularly poorly in the detection of benzodiazepines (Logan et al., 2014).

Roadside tests. Roadside tests, or field tests, are oral fluid collection devices that allow for presumptive positive readings to be obtained immediately by law enforcement. These tests require follow-up with confirmatory testing, but their advantage lies in their ability to supplement any conclusions made by law enforcement officers when conducting behavioral tests. There are several types of oral fluid drug tests currently on the market. Several brands were compared in the Rosita-2 project, which was a large-scale evaluation of several roadside oral fluid drug testing devices performed by a collaboration of organizations in Europe and the U.S. (Verstraete & Raes, 2006). The DRUID project also compared several different devices (Schulze et al., 2012). Each of these projects showed that oral fluid tests present viable alternatives to blood tests at roadside, but these data are not presented exhaustively here.

The quality of a drug test device is based on a combination of sensitivity (the extent to which the drug is detected when it is present) and specificity (the extent to which the test does not detect the drug when it is not present). Accuracy is an overall measure that combines results of sensitivity and specificity data. The Mavand RapidSTAT®, Securetec DrugWipe-5+®, and Dräger Drug Test 5000® have all demonstrated high accuracy for amphetamine (86%, 87%, and 94% accurate, respectively; Wille, Samyn, del Mar Ramírez-Fernández, M., & De Boeck, 2010). Logan et al. (2014) also compared the Dräger Drug Test 5000® with a similar device, the Affiniton DrugWipe®. Although there were differences in detection between the two tests, these differences occurred primarily for marijuana. These two tests did not differ in the detection of the prescription drugs that were tested. While both tests performed well at detecting oxycodone and amphetamine, neither of these tests were effective at detecting benzodiazepines.

Thus, each of the devices noted is a promising roadside oral fluid testing device, but there is still a need for roadside tests that can reliably detect benzodiazepines. This difficulty is in part due to the acidity of benzodiazepines, which prevents the drug from being ionized in

oral fluid (Drummer, 2008). Current research supports the use of blood with ultra-performance liquid chromatography tandem mass spectrometry (UPLC-MS/MS) to determine presence of benzodiazepines reliably (Sauve, Langødegård, Ekeberg, & Øiestad, 2012). In addition, the Securetec DrugWipe® Benzodiazepines, designed to overcome the obstacles of detecting these drugs, performed fairly well in the Rosita-2 project, showing 79.2% accuracy (Pehrsson, et al., 2008). Although this is still relatively low compared to other drugs, the test has since been improved by lowering the cut-off value for which benzodiazepines can be detected. The test is at least feasible for initial confirmation of law enforcement identification of benzodiazepine impairment.

Because collection of oral fluid is a less invasive procedure than blood testing, individuals may be more likely to provide these specimens, resulting in more accurate estimates of drugged driving. Further, some evidence indicates that individuals who refuse blood tests are more likely to test positive for drugs (Van der Linden, Legrand, Silverans, & Verstaete; 2012). However, this study did not test for prescription and OTC drugs with the exception of amphetamine, and this drug was only found in the blood of two drivers out of 2,750.

Urine testing remains appropriate when detecting long-term drug use is of interest. For example, urine testing with enzyme linked immunosorbent assay (ELISA) is useful for determining drug use in drivers who are seeking license re-granting following an offense that resulted in revocation (Agius, Nadulski, & Moore, 2011). Hair testing has also been used for license re-granting. As is the case with any matrix, when performing hair testing, standardized protocols must be followed or there is a risk of invalid results. For example, the portion of hair (proximal or distal to the head) used for testing and its length both affect the results of hair tests (Stramesi, Polla, Vignali, Zucchella, & Groppi, 2007). An expert interviewee also discussed this issue, commenting, “There are a couple of large trucking firms that are currently doing pre-employment hair testing...The problem is that every company that does hair testing has a completely different protocol for performing it, which makes it hard to validate. Congress has asked the DOT [the Department of Transportation] to use hair testing, but it will need to go through HHS [the Department of Health and Human Services] first to certify the lab, and they have yet to agree on a protocol that provides reliable and validated results. It’s not clear how long this process will take.”

Exceptions: Differentiating heroin from codeine. The prescription drug codeine and the illicit drug heroin metabolize into morphine, but heroin also has the unique metabolite 6-acetylmorphine, or 6-AM. Unfortunately, 6-AM is rarely present in blood after two hours following administration, but it does remain in urine for approximately 24 hours (Cone, Welch, Mitchell, & Paul, 1991). Therefore, urine tests can be crucial in differentiating between impaired drivers under the influence of codeine and heroin. In Sweden, urine testing of opiate-positive samples revealed that 85% were due to heroin use (Ceder & Jones, 2001). In addition, because only 2.3% of the opiate-positive cases were also positive for 6-AM in blood, urine testing can be necessary to reveal the specific drug consumed when opiates are suspected.

Test for a Wide Array of Prescription and OTC Substances. A great deal of the literature surrounding drugged driving concerns marijuana. Indeed, THC has been the most common drug found in drivers in NRSs (Lacey et al., 2007), and it is also the most common drug

reported by toxicology laboratories to be found in tests (Logan et al., 2013). However, toxicology laboratories report that alprazolam, diazepam, and morphine are equally as likely to be included in their top 20 drugs, closely following THC as the most common drugs found. Oxycodone, hydrocodone, carisoprodol, meprobamate, and zolpidem are also quite common. Therefore, while THC may be the most common drug found in drivers, the existence of such a varied array of prescription and OTC drugs that may also be present makes researching their involvement in impaired driving necessary as well, albeit more challenging.

While it has been widely established in the literature that oral fluid provides a less invasive and equally valid alternative to blood, many studies comparing different matrices have chosen the “NIDA 5” drugs of abuse (marijuana, cocaine, amphetamines, opiates, and PCP) as the compounds of interest. Therefore, many prescription and OTC drugs that impair driving have not been evaluated in terms of their levels in blood and in oral fluid. While the data regarding opiates and amphetamines is valuable, much research focuses on the detection of the illicit use of drugs (some of which are prescribed) and may overlook the importance of researching the detection of legal (but impairing) drugs. In addition, while opiates and amphetamines are indeed prescribed drugs, they are often included in drug test panels partially due to their classes encompassing the metabolites of the commonly abused drugs 3,4-methylenedioxymethamphetamine (MDMA) and heroin. For example, while morphine and amphetamine are themselves prescription drugs, amphetamine is a metabolite of MDMA (“ecstasy” or “molly”) and morphine is a metabolite of heroin.

While the detection of each of these drugs is important regardless of their status as prescription or illicit drugs, the latter are often a central focus. This focus on illegal use of drugs is unfortunate considering that, as Dr. Richard Compton, “From a public health and safety point of view, you don’t really care if a substance is legal or illegal if it’s causing deaths or injuries.” During the beginning of NHTSA’s research focus on drugged driving, “a lot of people wanted to focus on illegal drugs as a particular matter of concern, whereas, on an exposure basis, it was rather obvious that prescription and OTC medications had the potential to be a large traffic safety problem... Hundreds of millions of prescriptions are written every year and there has been accumulating evidence that many prescription and OTC medications have the potential to impair driving-related skills.” Therefore, drugs of interest to include in research on toxicological detection include antidepressants, antihistamines, and benzodiazepines. Studies do sometimes include several prescription and OTC compounds in their drug test panels, but they are not always sufficiently prevalent to be included in all analyses or to draw certain conclusions from the data (e.g., Wille et al., 2009). Research using more comprehensive drug test panels for prescription and OTC drugs would aid in creating a large body of credible research on detection of all impairing drugs (both legally and illegally used) in biological samples.

Law Enforcement and Judicial

The legal system represents a broad, complex, and evolving set of countermeasures to reduce prescription and OTC drugged driving. This includes laws that are designed to deter and punish impaired drivers, law enforcement officers who are tasked with identifying and processing impaired drivers, and numerous critical personnel who impact the judicial system. These judicial personnel not only include prosecutors, defense attorneys, and judges, but also key individuals who may impact the final disposition of a case or provide critical judicial outreach or training: toxicologists, police officers, judicial outreach liaisons (JOLs), and traffic safety resource prosecutors (TSRPs). All of these personnel and areas of the legal system serve as a crucial category of countermeasure providers.

Several efforts to reduce drug-impaired driving are already underway within law enforcement and the judicial system, including the Drug Evaluation and Classification (DEC) program, which trains law enforcement officers to become DREs. Currently, there are more than 8,000 DREs in the U.S. (IACP, 2016). Law enforcement officers also have the ability to become trained through the Advanced Roadside Impaired Driving Enforcement (ARIDE) program, which provides a level of expertise between the DEC program and SFST training (International Association of Chiefs of Police [IACP], 2017a).

Other efforts have emerged through laws that address drugged driving. Drugged-driving laws vary widely among states. A review by Walsh (2009) identified three general types of laws that states have implemented, which are categorized below in terms of the conditions that must be met in order to be charged with an offense:

1. The drug(s) must result in the driver being incapable of driving safely.
2. The drug(s) must impair the ability to operate a vehicle safely or the driver must be under the influence of or affected by an intoxicating drug.
3. The drug or metabolite must be present in the body while operating a vehicle (per se laws). There are two types of per se laws:
 - a. Those that prohibit the presence of the drug at or above a specified level.
 - b. Zero-tolerance laws that prohibit any amount (or more than negligible amounts) of the drug or metabolite in the body.

Per se laws themselves also vary by state and affect whether individuals with valid prescriptions can be arrested for prescription and OTC drugged driving. Additionally, if an individual is convicted of a drugged-driving offense under the influence of prescription or OTC drugs, it may be necessary to tailor treatment and rehabilitation differently than for individuals arrested for drugged driving involving illicit drugs.

Traditionally, the legal system was designed with a focus on drivers impaired by alcohol, and there are still policies and procedures remaining that reflect this focus: DUI laws, DUI courts, toxicology, and law enforcement training. As the recording of data from drugged driving cases improves, and as toxicological analyses become more precise, law enforcement officers are being tasked with implementing revised protocols. Judicial officials are also

seeing changes in the prevention and treatment programs available for offenders due to an increased focus on addressing drugged driving. In addition, as state laws continue to adapt in the way that they address drugged driving, law enforcement, toxicology, and the courts will prove essential in providing data from modified drug-testing, drug-treatment, and apprehension efforts. As drugged driving is being brought to the forefront, special consideration needs to be taken to address prescription and OTC drugged driving in particular, which presents law enforcement and judicial personnel with very different challenges than illicit drugged driving.

Issues related to data recording and differences in toxicological analyses can greatly impact analyses of the effects of law enforcement and judicial countermeasures. Thus, many themes in the present section are also informed by the Data Recording and Toxicology section. The central focus of the present section is on the outcomes of law enforcement and judicial efforts on the prevalence of drugged driving (including recidivism), or their impact on crashes. This is in contrast to the Data Recording and Toxicology section, which focuses on chemical detection and standardization of methods. The main countermeasure areas within the law enforcement and judicial domain lie within drugged driving laws, behavioral tests for impairment, advanced law enforcement training, consequences for drugged driving offenders, and licensing restrictions.

Systematically Research Effects of Per Se Laws on Arrests, Convictions, and Crashes. The effect of per se laws on traffic outcomes remains an area of great interest to the public and researchers. Numerous practical and methodological challenges make strong conclusions in this area difficult. For example, state laws differ widely in the specific drugs covered under each law and the manner in which laws are enforced. Many states specify that legal prescription drug users are exempt from these laws, adding to the lack of consistency across states (Lacey et al., 2010).

Empirical studies are emerging in regards to the impact of per se laws on drugged driving. One study found that the implementation of per se laws for drugged driving was associated with an 11% decrease in traffic fatalities before controlling for other factors. After controlling for state-specific variables such as mean age of the driving population, unemployment rate, and texting bans, there was no longer a statistically significant relation between drugged driving per se laws and traffic fatalities (Anderson & Rees, 2015). One factor that was not controlled for was the type of per se law in the state (e.g., which drugs were included in the laws). This may have been due to a focus on the changing marijuana laws in the study or because there are too many nuanced differences across states. Unfortunately, this study also relied upon FARS data, which strongly limits the study's findings.

In Norway, per se laws were developed for several prescription and illicit drugs at limits designed to correspond to impairment by alcohol at levels of 0.02 g/dL. Following implementation of these laws, Vindenes et al. (2014) found a 20% increase in the number of blood samples collected in suspected drugged driving cases and a 17% increase in the number of samples that were positive for at least one drug. It is important to note that, like many U.S. state laws, the per se laws in Norway do not apply to individuals who legally

possess a prescription. Similar limits were also imposed in Denmark in 2007. Following implementation of these limits, Steentoft, Simonsen & Linnet (2010) found a fivefold increase in the number of cases investigated for drugged driving under either prescription or illicit drugs. The majority of cases showed drug concentrations above the imposed limits, but the percentage of positive tests for drugs decreased following the legislation.

The objectives of the above studies necessitated testing for various prescription drugs to examine effects of legislative limits on their presence. As a result, their data included several benzodiazepines and two sleep aids. The use of a comprehensive drug panel allowed the studies to account for prescription drugs other than amphetamines and opiates, in contrast to many other studies. The comprehensive drug panels proved quite useful, as other drugs were prevalent in both of the samples. Steentoft et al. (2010) found that benzodiazepines were the most common drug found in drivers, accounting for between 29–55% of cases in their drugged sample, and per se limits resulted in a reduction in the percentage of positive tests for benzodiazepines. Similarly, two benzodiazepines, methamphetamine and amphetamine comprised the four most commonly detected drugs in Vindenes et al. (2014). These findings highlight the need for research that includes comprehensive drug panels.

The Vindenes et al. (2014) and Steentoft et al. (2010) studies also highlight the complexity of performing policy analyses in this area. Both studies found a significant change in drug testing procedures. Specifically, drug testing increased dramatically following implementation of per se laws. Since the results of these drug tests are often used as the outcome measures in research (e.g., raw changes in the number of drugged driving arrests pre- and post-implementation), there is a natural confound when using these data. Increasing the frequency of drug testing will likely result in a greater frequency of positive test results and a potentially-lower percentage of positive results because drug testing may be performed in less obvious cases of impaired driving.

In Sweden, zero-tolerance per se laws were introduced in 1999. These laws include prescription drugs, but evidence of impairment must also be demonstrated in order to prosecute such cases. An increase in the number of individuals apprehended was seen following the implementation of these laws (Jones, 2005), which prompted Holmgren, Holmgren, Kugelberg, Jones, & Ahlner (2008) to examine re-arrest rates of those arrested during the years that followed. The researchers found that the re-arrest rate was highest for drugged drivers who used illicit drugs (68%), followed by those taking licit drugs for medical conditions (17%), and alcohol-impaired drivers (14%). The re-arrest analysis was completed after, but not prior to, the implementation of the zero-tolerance law, which was a limitation of the study. Still, the evidence suggests that the rate of re-arrests for licit prescription drugged driving is similar to that of alcohol-impaired driving when such laws are in effect. In addition, illicit drug use appears to be a crucial factor in predicting whether an individual re-offends.

While the literature review revealed some evidence that per se laws may decrease prescription drugged driving, experts were wary of per se laws for several reasons. One point of contention at the roundtable was in regards to the implications of per se laws on individuals who take prescriptions as directed. There is concern that individuals may

develop tolerance to medication they take regularly and thus may not be impaired while driving, even with high levels of the drug present in bodily fluid. Yet, these individuals could still test above the per se limit for an impairing drug. This would certainly be the case in a zero-tolerance state. This highlights some of the challenges with zero-tolerance and per se limits in relation to prescription and OTC drugs. Additionally, it demonstrates the need to differentiate the illegal and legal usage of these drugs in research and policy.

Rooney et al. (2017) examined samples that had been collected prior to the introduction of per se limits for several prescription and illicit drugs (e.g., benzodiazepines, opioids, and stimulants) in England and Wales and showed that individuals taking drugs for medical conditions were unlikely to show drug levels over newly implemented per se limits. However, the same individuals would not have avoided consequences under zero-tolerance per se laws. Future studies should not only differentiate the prescription drugs under which individuals drive impaired, but also whether they are used legally or illegally.

Develop Behavioral Tests for Impairment. The development of behavioral tests is a critical countermeasure for identifying drug-impaired drivers and safely removing them from public roadways. Behavioral tests provide information that toxicology tests do not, as the presence of a drug does not necessarily indicate impairment by it. SFSTs are designed to use a battery of three tests to identify drivers impaired by alcohol: the One Leg Stand (OLS), Walk and Turn (WAT), and Horizontal Gaze Nystagmus (HGN) (Burns & Moskowitz, 1977). The OLS test requires an individual to stand on one foot for 30 seconds and count by one beginning from 1,000. If the individual sways, uses their arms to balance themselves, hops, or places their foot down, these behaviors are scored as indicators of impairment. The WAT requires the individual to step in a straight line with one foot directly in front of the other for nine steps. Finally, the HGN test is performed by instructing the individual to follow a pen or other moving object as it moves horizontally. Officers examine each eye as it moves for three characteristics of nystagmus (a jerking movement of the eye) that are present when an individual is impaired. There are several indicators of impairment in these tests, which are outlined in greater detail elsewhere (Burns, 1987; Stuster & Burns; 1998).

As noted, the SFST battery was originally designed to detect alcohol impairment and has not been fully validated for detection of other drugs. The literature regarding prescription and OTC drugs is particularly sparse. Examination of more than 2,000 cases in Canada from 1995-2009 revealed that the SFST battery was generally adept at detecting drugs of various classes. However, because these evaluations often focus on illicit drugs, the data presented did not specify illicit versus licit drug presence. Thus, it is unknown how many of the cases observed involved prescription or OTC drugs (Porath-Waller & Beirness, 2014).

Of the three SFSTs used in Porath-Waller & Beirness (2014), the HGN was the most successful in classifying cases involving drugs other than alcohol. Of the drug categories that were present, HGN was most successful at classifying central nervous system (CNS) stimulants (94.6% correct) and CNS depressants (70.1% correct). However, HGN did not correctly classify any cases involving narcotic analgesics. The OLS was also effective at distinguishing individuals who had consumed drugs versus those who had not. However, in

terms of determining classes of drugs, it only classified stimulants correctly in 55.4% of individuals. The OLS test as a whole was also ineffective at classifying cases of narcotic analgesics (10.6% correct), although users of this drug class were more likely to put their raised foot down during the test. Finally, the WAT showed similar results for CNS stimulants and narcotic analgesics (72.2%, and 3.5% correct, respectively), but was not as successful at detecting CNS depressants as the other two tests (9.0% correct). Individuals using each of these drug classes were less likely to maintain balance compared to those who did not test positive for drugs.

These results indicated that the use of SFSTs results in unreliable classification for narcotic analgesics in particular, though users of these substances still display behaviors that are indicative of impairment by a drug in general. SFSTs do not have significant utility in predicting many other prescription drugs, and further analysis seems necessary to determine impairment by narcotic analgesics (e.g., DRE evaluations, outlined below). In addition, certain drugs appear particularly difficult to detect using SFSTs, including low doses of CNS stimulants (Silber, Papafotiou, Croft, & Stough, 2005) and the antidepressant trazodone (Ip et al., 2013). It is also necessary to determine which drugs are the most important to target, as impairment of driving performance by the above drugs at therapeutic doses has not been universally demonstrated (Kay, Michaels, & Pakull, 2009; Sasada et al., 2013). Still, impairment from these or other typically non-impairing drugs could result from ingesting larger doses than prescribed, or illegal use. In addition, some portions of the SFST battery are associated with cognitive impairment (Downey, Hayley, Porath-Waller, Boorman, & Stough; 2016), which may present a limitation of SFSTs when testing for prescription drug use. More research is needed to determine whether the ability of SFSTs to detect drug impairment is reliable.

Advanced Law Enforcement Training Programs

There are an increasing number of advanced law enforcement programs that provide rigorous training in identifying impairment by drugs. There are two advanced programs for law enforcement officers that extend beyond training in SFSTs: the DEC program and the ARIDE program. The ARIDE program presents education and training in the signs of drug use at a level between SFSTs and the DEC program.

The ARIDE program bridges the gap between SFSTs and the DEC program by instilling officers with greater knowledge related to drug impairment, while also encouraging ARIDE-trained officers to utilize DREs in their states. The program focuses on the prevalence of drug use, seven categories of drugs, effects of drug combinations, and arrest procedures. While knowledge from the DEC program is provided to ARIDE-trained officers, it is not intended as a substitute. There is less classroom training, no final knowledge examination (as with the DRE program) and no need for field certifications.

The DEC program is a more intensive training in which officers can become certified as DREs. Once certified, DREs can be called out to potential drug-impaired driving cases to provide an expert analysis. DEC trains officers to detect signs of impairment by specific drug classes and their combinations using a 12-step approach. The approach and

corresponding impairment indicators are shown in Table 3 and were based on the Instructor Guide for the DEC program (NHTSA & IACP, 2015). The SFSTs are included in the 12-step approach, but more in-depth tests are also included. DREs examine several physical, cognitive, and motor indicators of impairment by drugs during their investigations that allow more specific targeting of drug classes (IACP, 2017b). Officers entering the DEC program are required to already be proficient in the use of SFSTs (IACP Highway Safety Committee, 2015).

Unlike SFSTs, the DRE evaluation is designed to specifically detect other drugs. The following seven categories of drugs are evaluated by the DRE: (1) central nervous system (CNS) depressants; (2) CNS stimulants; (3) hallucinogens; (4) dissociative anesthetics; (5) narcotic analgesics; (6) inhalants; and (7) cannabis. These categories will capture a variety of drug usage from prescription drugs. For example, CNS depressants includes anti-anxiety tranquilizers (e.g., Valium, Librium, Xanax, Prozac) and other antidepressants (e.g., Zoloft, Paxil). Narcotic analgesics include codeine, Demerol, Vicodin, and OxyContin. It should again be highlighted that prescription drugs can be used as prescribed or abused illegally, but the DRE evaluation itself is not designed to differentiate this usage. It is unclear to what extent OTC drugs are easily evaluated by the DEC program.

Require ARIDE training for all officers. The ARIDE course, which presents a level of training between SFSTs and DEC, is a 16-hour program that trains officers to recognize drug impairment. Experts at the roundtable recommended that law enforcement move toward training all law enforcement officers in ARIDE protocols. Although research has begun to assess the DEC program in detecting prescription and OTC drug-impaired drivers, there are currently no published studies evaluating ARIDE in this regard. However, NHTSA representatives reported that a recent project has been completed assessing the ARIDE program, which will be released in the coming months.

Continue to evaluate and improve the DEC program. The DEC procedures were originally evaluated by Bigelow, Bickel, Liebson, & Nowowieski (1985), who showed that their accuracy ranged from 43.5% for d-amphetamine to 92.9% for secobarbital. Other prescription drugs included depressants and diazepam, showing 77% and 71.2% accuracy, respectively. Beirness, LeCavalier, & Singhal (2007) systematically reviewed this first evaluation and subsequent efforts in both laboratory and field settings. There was a wide range in accuracy levels compared to Bigelow et al. (1985), with some studies demonstrating higher accuracy and others much lower accuracy in detection of drug classes. Still, results generally showed that overall, DREs are accurate at detecting drug use and drug class at least above chance, and at most (excluding categories comprising only illicit drugs, e.g., phencyclidine) above 90%. Field studies showed better detection and classification than laboratory studies, which may be due to the use of standardized doses that were not as high as those self-administered by drivers encountered in the field.

Beirness et al. (2007) called for improvements to the DEC program due to the fact that the wide range of accuracy leaves many cases missed or classified incorrectly. Part of the reason for this wide range of accuracy concerns variability in detection of drugs by class, as stimulants are one class that appears particularly difficult to detect. It is important to note that studies evaluating the DEC program often vary in the drugs or drug classes of interest,

as was the case for the studies chosen in Beirness et al. (2007). While prescription drugs are typically included due to their belonging in at least one category, their level of representation throughout the data varies somewhat.

Table 3. DEC 12-step process and indicators, based upon the DEC Preliminary School Instructor Guide (NHTSA and IACP, 2015).

12-Step Process	Example DEC Indicators or Assessments
1. Breath alcohol test	BAC at lower levels in a seemingly impaired person may indicate a higher likelihood of other drug use
2. Interview of arresting officer	Evidence of drug use, e.g., paraphernalia, driving behavior, or statements
3. Preliminary examination and first pulse	Abnormal pupil size. Abnormally high or low pulse rate, temperature, or blood pressure
4. Eye examinations	HGN, vertical gaze nystagmus, lack of convergence
5. Divided attention tests	Modified Romberg Balance, WAT, OLS, Finger to Nose
6. Vital signs and second pulse	Abnormal pupil size. Abnormally high or low pulse rate, temperature, or blood pressure
7. Dark room examinations and ingestion examination	Abnormal pupil size/reaction to light
8. Check for muscle tone	Markedly tense or flaccid muscle tone
9. Check for injection sites and third pulse	Abnormal pulse, presence of injection sites
10. Suspect statements and other observations	Statements regarding drug use
11. Opinion of evaluator	N/A (Officer records whether s/he believes drugs were involved and if so, the probable drug class)
12. Toxicological test	i.e., blood, oral fluid, or urine test

Streamline the DRE evaluation process to reduce testing length. Some concern has been expressed over the length of the DRE testing process. Because the evaluation is comprehensive, it also typically requires more than an hour to complete. Drugs can metabolize in the body during this process, which may result in a negative biological sample even when impairment is present. Efforts have been made to examine the efficacy of an abbreviated DRE battery, including a study by Porath-Waller, Beirness, & Beasley (2009), who identified the nine indicators that proved to be the best predictors of drug impairment: pulse rate, condition of the eyes, condition of the eyelids, lack of convergence, hippus (pupil movement), reaction to light, rebound dilation, systolic blood pressure, and the presence of injection sites. These results only applied to the CNS stimulant, narcotic analgesic and cannabis drug categories. Similarly, Porath-Waller & Beirness (2010) examined the indicators that served as best predictors of impairment by three drug combinations: CNS stimulants and cannabis, CNS stimulants and narcotic analgesics, and cannabis with alcohol. Some drug combinations, particularly CNS stimulants/cannabis, are

difficult to predict, whereas others, such as CNS stimulants/narcotic analgesics, are easier to predict.

There have also been attempts to validate the indicators which contribute most to correct drug identification. Although not all drug combinations with prescription and OTC substances have been evaluated empirically, studies show that when identifying any drug class, there is generally a trade-off between accuracy and timeliness of the evaluation. For example, exposing the participant to a greater number of tests increases the probability that the drug will be correctly classified, but it also increases the length of the evaluation.

Because there are specific indicators that appear more influential than others, the authors were able to suggest that simplification of the evaluation process may be possible. Focusing on some indicators over others, depending on the circumstance, may save DRE officers time when conducting evaluation in the field and reduce the delay in collection of biological specimens. However, there is also a current debate over whether the biological specimen should be collected at the beginning rather than the end of a DRE evaluation, which would also resolve the issue of drugs metabolizing quickly during the tests.

Utilize expert recommendations to improve DEC programs. Regardless of any limitations and areas needed for further research, the DEC program possesses strengths that simply cannot be ignored or overlooked. Investment in maintaining and refining the DEC program, a standardized, evidence-based, and systematic method for detecting impairment, should continue. As expert interviewee and toxicologist Joseph Jones stated, “I believe that there is a hurdle in understanding the rigorous curriculum that [DREs] have to go through to get certified. I’ve gone through DRE school and I get to teach it. It is very difficult. If we could invest better in that program, I believe it could be so much more effective. If court personnel and toxicologists would appreciate it more, and if officers defend what they are capable of doing, [the program will benefit].” In addition, Dr. Barry Logan, an expert toxicologist from the roundtable, generated a list of recommendations for DEC programs comprised of the following (adapted from a personal communication following the roundtable):

1. Appoint a full-time DRE coordinator whose sole job is the maintenance and development of the state DRE program. This individual should be proactive and out in the field—touching base at trainings, engaging with the state traffic safety office, providing public speaking presentations to promote the program, etc.
2. Maintain a database of state DRE activity and use this to manage the program, publicize the program’s contributions, and identify problems.
3. Give the DRE coordinator administrative support to coordinate, collect and organize data from evaluations, prepare an annual state report on DRE activity and program highlights, schedule and manage logistics for the various training events, and enter the DRE evaluation data for all DREs in the program into the NHTSA DRE database or the state equivalent. Prepare and distribute an e-newsletter(s) to DREs and agency managers highlighting successes and interesting cases encountered or prosecutions supported by the program.

4. Build a strong and interactive relationship with the toxicology resource that supports the program. Participate in each other's training.
5. Increase the minimum number of evaluations each year over the four per year (averaged over two years) required by IACP to maintain the certification.
6. Promote interagency cooperation and DRE resource sharing. Get agencies to agree to have DREs sign in with the local communications center when they go on shift and be available to other agencies for evaluations.
7. Have upper management support for the DREs to get overtime approval for completing evaluations occurring late in the shift. Often DREs are told not to take a call because they will run into overtime.
8. Work to have rising stars maintain their DRE certification and buy-in in the program as they are promoted through the agency into its leadership.
9. Provide a financial incentive/specialty pay to officers to get and maintain their DRE certification (this incentive in the state of Washington was \$500 and was negotiated by the troopers union).
10. Mandate a DRE callout in certain types of cases, especially fatal crashes, to do a "screening" of the surviving driver, not necessarily a full evaluation.
11. Use ARIDE training as a pathway to greater utilization of DREs.

These recommendations were broadly supported by the other panelists at the expert roundtable. The practicality and barriers to implementation broadly vary within these 11 recommendations. Many of the recommendations rely on buy-in and support from key administrators within a state. This includes financial support, which may not be available in a given state. These recommendations may be particularly challenging in a smaller state without a large number of DREs. For example, many small states find it difficult to have the financial resources to have a full-time DRE coordinator. Yet, these recommendations offer tremendous potential if the state is willing to invest in the time and resources it would take to implement feasible options within their state.

Modification to the Legal System

Drug courts are programs for offenders of drug-related crimes that involve drug testing, substance abuse treatment, and contingent sanctions or rewards based upon offender performance. These programs also involve interaction with a multidisciplinary team of treatment providers, law enforcement, and judicial personnel. Drug courts are a highly regarded, evidence-based and cost-effective method for reducing drug-related criminal recidivism (Marlowe, 2010).

Separate drug-impaired and alcohol-impaired driving in statutes. When drug courts are used for DUI offenses they are sometimes called DUI courts. DUI courts focus more on driving but also heavily focus on rehabilitation for alcohol abuse. Unfortunately, some drugged driving offenders find themselves in DUI courts that do not address drugs. For

example, they may be required to install an ignition interlock device in their vehicle to detect the presence of alcohol, even though their driving impairment was caused by a drug. Separating drugged driving and alcohol-impaired driving offenses may aid in tailoring treatment to each individual.

Utilize behavioral triage. Behavioral triage is a technique that involves placing individuals into different tracks based upon their behavior and risk of recidivism. These tracks involve different frequencies of meetings, court appearances, trainings, and other consequences for offenders. Testing positive on a drug test is considered evidence for movement to a more intensive track with increased monitoring. Carey, Allen, Einspruch, Mackin, and Marlowe (2015) evaluated the behavioral triage program in San Joaquin County, California, by comparing the years after it became required for all DUI offenders with previous years during which it was not required. The program's more intensive track involved graded sanctions and rewards during a full DUI court program. Offenders were required to attend court weekly, and they met with a court team prior to sessions in order to decide on incentives and sanctions. They were required to be compliant with all requirements for a minimum of one year in order to complete the program, and could move to a less intensive track if they were successful. The less intensive track required biweekly counseling, attending court approximately every six months and providing drug test specimens. Individuals enrolled in this program had fewer new convictions compared to those in traditional probation during the 18 months following their offense. They also had fewer license suspensions and revocations, and fewer crashes (both drug and non-drug related). This study did not specify whether offenders had been arrested for drugged or drunk driving, but the program staff estimated that 75% of participants were poly-substance users, including prescription drugs.

Motivational interviewing and behavior plans. Prime for Life (PFL) is a prevention program that uses a "motivation-enhancing, and non-confrontational group approach" to prevent substance abuse (Beadnell, Nason, Stafford, Rosengren, & Daugherty, 2012). The program presents data on the risks involved in substance use and uses techniques based on motivational interviewing. It has been used as a court-ordered intervention for DUI offenders. In response to the lack of empirical evaluations of the effectiveness of this program, Beadnell et al. (2012) compared PFL to an "intervention as usual," which was similar except motivational techniques were encouraged, rather than standardized, and personnel were not intensively trained or given required content to cover. Although PFL participants reported fewer intentions to use substances and other positive outcomes (e.g., greater understanding of drug tolerance), there were very few self-reported drug users in the study (less than 15% of the sample), and the study did not differentiate between outcomes across alcohol and other drug users. Finally, because there were no recidivism data collected, it is difficult to infer whether PFL has promise as an effective intervention in drugged driving offenders. Studies showing promising results on re-arrest rates following a PFL intervention have also not differentiated drugged driving offenders from drunk driving offenders (e.g., Beadnell, Crisafulli, Stafford, Rosengren, & DiClemente, 2015). Because PFL does not solely focus on alcohol and addresses substance use in general, the generalization of the program to drugged driving offenders is unclear. Future studies evaluating such programs should differentiate between offender histories.

Another similar DUI intervention that addresses drugs other than alcohol within the curriculum is the Mississippi Alcohol Safety Education Program. This program has shown lower recidivism rates for those completing it compared to those who did not enroll (Robertson, Gardener, Xu, & Costello, 2009). The program uses written behavior plans for avoiding recidivism, enhancing motivation (similar to Beadnell et al., 2012) and providing personalized information regarding risk of recidivism. However, this intervention has also not been evaluated for drugged driving offenders specifically.

Utilize biomarkers to detect drug use in repeat drugged driving offenders. Biomarkers can be used to detect drug use in repeat drugged driving offenders without the need for repeated testing. A recent evaluation of one program in Kenosha County, Wisconsin, used biomarkers in fingernails for this detection. The study determined that this program was convenient and objective for detecting risk of a repeat offense (Bean, Brown, Hallinan, Becerra, & Lewis, 2017). Drugs can be present in nails for up to eight months following their use, so this program was able to use a testing frequency in which three months was the shortest time period between tests. The program provided the behavioral incentive to terminate testing earlier if results were negative, and found a low re-arrest rate for all offenders, including those who did not complete the program (7.7%). However, there was insufficient data to determine if this low re-arrest rate was meaningful compared to other similar programs. Because only a subset of drivers were tested for drugs, and amphetamines and opiates were the only prescription drugs included, it is difficult to determine the feasibility of biomarker programs for detecting prescription and OTC drug use. In addition, the selection of this subset depended on self-reported drug use, and these individuals were more likely to relapse than the group only reporting alcohol use. By the time the study was published, the nail testing panel used had been expanded to detect up to 12 drugs of abuse, and the authors report that other counties in Wisconsin have been developing similar programs for repeat offenders.

Licensing Guidelines

Drugged driving may also be prevented by carefully reviewing individuals applying for licenses or by placing restrictions on renewed licenses. Licensing restrictions concern laws or requirements specifying actions that must be completed prior to issue or renewal of a driver's license. Licensing restrictions may also refer to laws or procedures specifying actions that can result in license suspension or revocation. These restrictions may be very important for preventing repeat drugged driving offenses and for identifying individuals who pose a risk due to a medical condition.

Require abstinence from drugs for post-offense re-licensing. State laws vary among the types of licensing restrictions that occur following a drugged driving offense but typically include license suspension and revocation of varying durations (Walsh, 2009). Many states impose escalating penalties based upon the number of offenses but generally allow eventual re-licensure. Several countries impose more stringent restrictions on license re-granting following an impaired driving arrest compared to most states in the U.S. One exception is New York, in which a license can be permanently denied for renewal if an individual has several DUI or Driving While Impaired (DWI) charges. Many European countries include

other types of licensing restrictions, such as a medical and/or psychological review, as part of their re-licensing process (Stewart, 2000). As knowledge is gained on prescription and OTC drug-impaired driving, re-licensing laws should be adapted to consider individuals who legally use drugs.

Germany recently evaluated its updated re-licensing system, which includes both medical and psychological review, plus drug testing for various drugs of abuse, including opiates and amphetamines (Agius, Nadulski, Kahl, & Durfaux, 2012). Updates to the process included a urine screening that was more sensitive at detecting drugs than the method used in prior years. This resulted in the ability to require that individuals be completely abstinent from any drugs not prescribed to them in order to qualify for re-licensure. Because any positive tests for legitimately prescribed drugs were ignored, screening results in Agius et al. (2012) only reflected drugs that offenders were using illicitly. However, the drug panel did include prescription opioids and amphetamines due to the potential for illicit use. The requirement to abstain from all non-prescribed (and non-OTC) drugs was termed a “zero-tolerance” approach (not to be confused with zero-tolerance limits for arresting impaired drivers) because the drug detection cutoffs allowed for precise detection of small amounts of drugs. Not surprisingly, detection of opiates increased from 0.3% to 0.7% of samples, and detection of amphetamines increased from 0.2% to 1.4% of samples. These results indicate that the more stringent testing cutoffs used in the new method capture many offenders who would have been re-licensed under the old method.

Train law enforcement officers to recognize medically at-risk drivers. A recent NHTSA-sponsored project with the Virginia Department of Motor Vehicles (DMV) created a training program for law enforcement officers designed to increase detection of medically impaired drivers using a medical review process carried out during traffic stops (Lococo et al., 2013). This process enables officers to better identify drivers who may be impaired due to an existing medical condition or use of medication. Although an empirical investigation before and after implementation of the training program was not possible due to study limitations, pre-intervention data were analyzed to determine the role of law enforcement in medically impaired drivers.

In Virginia, the medical review process begins when an officer completes a medical review request form during a traffic stop with a potentially impaired driver. The DMV’s medical review department then takes steps to evaluate the driver, which can include road testing and requiring the driver to obtain documentation from their physician, using Virginia DMV’s medical review program. The process may end in license suspension, license restrictions (such as provisions against night driving), and/or entrance into a driver rehabilitation program. The license may be revoked if the driver refuses to complete any of the necessary steps.

Lococo et al. (2013) found that law enforcement officers are both critical for and accurate in identifying impaired drivers for medical review. In fact, 88% of medical review requests by law enforcement officers resulted in either license suspension, restriction, or periodic review. Adults older than age 70 represented the majority of the sample of individuals referred for medical review, calling attention to the importance of targeting countermeasures toward older adults and training law enforcement to recognize

impairment in these drivers that may be caused by their medications. The authors concluded that the recently developed training programs for law enforcement are a worthwhile focus due to officers' prominent role in referring these drivers to the DMV. Thus, further training for officers on identifying medically at-risk individuals, including impairing prescription or OTC drug use, may increase the effectiveness of the medical review process even further.

A medical review process may also be useful for commercial transport. Dr. Mary Pat McKay commented, "In rail, for instance, there is no requirement to review vital signs, medications, or medical conditions prior to certifying someone to be an engineer of a metro north commuter train, or a hazmat train, or anything else. We feel strongly that this is a problem. And it's not just illicit use of drugs. Some of it is the use of prescription medications that can be impairing and lead to bad outcomes."

When identifying medically at-risk individuals, prescription drugs can play an auxiliary role compared to the condition itself. This does not necessarily present a barrier to the medical review process but could be an area where officers are trained to focus their attention. Although the officers in Lococo et al. (2013) could have submitted medical review requests on the basis of self-reported prescription drug use, only two cases comprised this category. It is unknown what percent of the total sample used potentially impairing prescription drugs or which drugs were present in these drivers, but efforts to reduce impaired driving with prescription and OTC drugs could place emphasis on the maintenance of an improvement of the medical review process. Thus, the medical review process could circumvent the barrier of apprehending prescription and OTC drivers who are not necessarily breaking the law in many states when driving under the influence of their legally prescribed drugs.

Education and Advertising

Education and advertising provide an opportunity to inform the public about the risks of OTC and prescription drug-impaired driving, as well as promote effective countermeasures. This is critical because the dangers of driving under the influence of prescription and OTC drugs are largely overlooked by the public. Because they are authorized by a doctor, prescriptions may carry a connotation of safety, while OTC medications are often viewed as less harmful due to their ubiquity. Many drivers would be shocked to learn that they could be arrested for impaired driving while taking their legally obtained OTC or prescription medication, but the knowledge of this potential consequence may be one of the most effective deterrents to impaired driving.

The literature search yielded many sources focusing on education to combat alcohol-impaired driving. While alcohol impairment remains a significant safety concern, there appears to be an abundance of information available to the public on the risks involved with driving after drinking alcohol. In contrast, the search yielded very few sources that focused on educating the public on prescription and OTC substances that can impair their driving. Further, a need may also exist to educate individuals on the interactions between substances, because impaired drivers often test positive for drug combinations, including

alcohol and/or marijuana combined with prescription and OTC drugs, or different prescription and OTC combinations.

Education and advertising countermeasures are not limited to targeting drivers. Individuals who interact with drivers and those who affect the outcomes of drugged-driving cases are equally important to target. These individuals can range broadly from prosecutors, judges, and court personnel to pharmacists and treatment providers. Although the range of target groups is quite large, there are few existing programs, and even fewer that have been evaluated using data beyond self-reports. Therefore, the education and advertising countermeasures in the current section were mainly derived from expert recommendations.

The countermeasures suggested by experts participating in the roundtable and interviews were abundant and diverse. One expert in behavioral research in traffic safety brought attention to three necessary elements to consider when using persuasion: source, message, and audience (originally described in Hovland, Janis, & Kelley, 1953). As recommendations emerged, it was clear that the aims and strategies of each recommendation centered around one of the three factors. Therefore, countermeasures in education and advertising are subdivided according to the factor upon which the recommendation focused. Source concerns the vehicle, deliverer, or setting in which the message is propagated and can involve the use of strategic settings or respected experts. The message factor involves creating content that is easy to understand or powerful, or uses other methods to create a larger or more effective impact. The audience factor focuses on targeting specific groups, such as those who are susceptible to prescription and OTC drugged driving.

Source

The source of the message—that prescription and OTC drugs can impair driving, resulting in hefty fines and fees, and can put lives at risk—should be chosen with consideration of the particular expertise, familiarity, or likelihood of consequences associated with the deliverer. For example, federal agencies can be powerful sources due to their expertise in drug evaluation. Advertising from drug manufacturers may also carry weight due to their knowledge about the product. State-sponsored programs could use unique state characteristics to make their message familiar and relatable, and messages from insurance providers or regulatory bodies could prompt an individual to consider the legal and financial consequences of their actions.

Driver's education classes. Experts clearly believed education on prescription and OTC drugs and driving should begin during the licensing process. Several organizations include content on their websites or in the educational materials that they provide to states. For example, DriversEd.com (2017) and Drivers Education Inc. (2017) both discuss the dangers of driving under the influence of prescription and OTC drugs. Several state DMV offices also address this topic, including the District of Columbia (District of Columbia Department of Motor Vehicles, 2017), California (Rogers, 2004) and New York (New York State Department of Motor Vehicles, 2017).

Automobile-insurance-led education programs. Similar to manufacturers, insurance agencies have a vested interest in deterring drug-impaired driving. Experts suggested that these companies collaborate with other agencies to develop advertising and education for their consumers. Esurance Insurance Services (2017) has information related to drugged driving on its website, including the statement that, “Any drugs, from legal prescription meds and over-the-counter (OTC) cold and allergy medications to illicit ones like cocaine, may quickly affect reasoning and motor skills.” The site also provides the warning that drugged driving can be costly due to the associated higher insurance rates. However, thus far, these insurance-led efforts have been relatively sparse.

Federal-agency-sponsored education programs. The FDA (2013) provides online materials to individuals interested in distributing information about driving while impaired by prescription and OTC drugs (such as healthcare professionals). These materials were developed in a partnership with NHTSA. The FDA also offers a webinar specifically addressing OTC drugs and driving (Mohamadi, 2017). Because the FDA is tasked with evaluating the safety of prescription and OTC drugs, a common call to action by experts was for the agency to increase its advertising and education. One newly developed countermeasure from the FDA was brought to the forefront by experts in government: The FDA will now provide evaluations of all newly developed prescription and OTC drugs’ potential effects on driving. That is, new drugs will be classified according to their risk for impairment. While these evaluations are not available for existing drugs, this step will still allow for an increased awareness of the potentially impairing nature of prescription and OTC drugs, and for specific drugs, going forward.

State-sponsored programs. State programs are very useful because they allow messages to be tailored to a state’s unique challenges, laws, and demographics. The Colorado Department of Transportation (2017) provides a poster alerting drivers to the risks of driving while using prescription and OTC drugs, which is available for download by interested parties (see Figure 3). This example might be customized by other states to address varying laws. One suggestion derived from the expert roundtable was for organizations to develop media toolkits for states so that standardized, effective techniques for advertising can be implemented based upon examples from successful states.

DRIVING UNDER THE INFLUENCE OF A PRESCRIPTION CAN BE THE SAME AS DRIVING IMPAIRED.

AVOID A DUI. CHECK YOUR PRESCRIPTION.






-  Some drugs purchased at a pharmacy, whether they're prescribed by a doctor or bought over-the-counter, can be just as dangerous for drivers as alcohol.
-  The effects of prescription medication vary widely, depending not just on the drug but on the person taking it. Some drugs can impair coordination and slow reaction time; others can hurt your ability to judge distances or can cause drowsiness.
-  Driving under the influence of drugs—including some prescription medications—can result in DUI charges. A doctor's prescription is no defense against drugged driving charges. Look for warning labels or ask your pharmacist if you are in doubt about a drug's capacity for impairment.



Figure 3. Colorado Department of Transportation poster that addresses driving while impaired by prescription and OTC drugs. From “Campaign Materials,” by Colorado Department of Transportation, 2016, (<https://www.codot.gov/safety/alcohol-and-impaired-driving/druggeddriving/assets/2016-campaign-materials/dui-poster-espanol.pdf>). Used with permission.

Manufacturer-sponsored education and advertising. Experts envisioned programs sponsored by manufacturers that would parallel campaigns sponsored by entities within the alcohol industry that aim to reduce drunk driving. These efforts may be hindered by manufacturers who would decline to participate in these efforts due to concerns that their products could be viewed as harmful. In fact, one expert at the roundtable reported a lack of success when approaching a large pharmacy chain about participating in a campaign that would place drugged driving educational material near the pharmacy counter. However, pharmaceutical manufacturers could also see some incentives in teaching the public to responsibly use their product to produce fewer incidents of drugged driving. An expert

interviewee noted that warnings of impairing drugs are not the only type of advertising needed. Manufacturers can also choose to advertise drugs that have been demonstrated to be safe to use while driving. “The drug companies have been very successful in direct marketing to the consumer...That makes them potentially really important partners for addressing this issue with both prescribers and the general public,” noted one of our expert interviewees. Cost of drug development may also be offset by increased sales of non-impairing drugs if they may be advertised as FDA-approved and non-impairing. Dr. Richard Compton noted these benefits to pharmaceutical companies as well, stating, “All it will take is a few drugs that get FDA approval that have established that their drug has no effect on driving. They’ll now have a great marketing tool against all the existing legacy drugs because they’ll say ‘approved by the FDA and does not impair driving.’ You won’t be able to say that for any of the legacy drugs because none of them will have been tested.”

Message

The content and design of a message should be tailored to maximize its comprehension and impact. The expert who noted the three factors involved in designing persuasive education and advertising did so because she believed strongly that the message is currently the most critical area of focus for preventing prescription and OTC drug-impaired driving. In particular, the majority of experts believed that individuals are unaware of both the nature of impairment that can be caused by these drugs and the potential consequences of driving while impaired by them. Messages should be tailored to address these areas where knowledge is lacking. These messages can also be targeted toward demographic groups that may be the most at risk (e.g., older drivers and polypharmacy drivers).

Signs of impairment. One valuable message is teaching the public the warning signs of impairment from prescription and OTC drugs. This recommendation was provided by experts who believed that vigilant family members can prove essential in preventing a loved one from unintentionally driving while impaired. The Partnership for Drug-Free Kids (2017) offers several resources regarding teen prescription and OTC drug use, misuse, and abuse, including a guide for detecting impairment in teens.

Combinations with alcohol and other drugs. Prescription drugs are often used in combination with other prescription drugs, OTC drugs, and alcohol. At times, drug combinations can prove more impairing than each drug used alone. In addition, for OTC drugs in particular, individuals may take a larger drug dose than they are aware of because many products contain multiple drug compounds. For example, many OTC cold medicines contain an antihistamine, decongestant, and pain reliever in a single capsule. If a driver is unaware of this and takes another OTC cold medication, the combination of doses may become more impairing. Thus, the public stands to benefit from education on the potential effects of combinations of medications, including those that produce dangerous effects, and how to identify multiple compounds within one product.

The public should also be informed on how to easily access information about effects of their medications on driving. WebMD’s Medscape provides a resource targeted to physicians and healthcare professionals that includes a drug interaction checker (WebMD, 2017), which

can also be used by consumers. The tool allows the user to input each prescription or OTC drug and receive results regarding any dangerous drug interactions that can affect driving performance. Increased awareness of such tools via advertising may aid in providing consumers with critical information about impairing medications.

Questions to ask pharmacists and doctors before driving while using a prescription. The wide array of prescription drugs can leave consumers feeling confused and afraid to speak up about risks. In addition, doctors and pharmacists who are pressed for time are unable to outline each and every warning or potential interaction. Experts were concerned that patients might not know the proper questions to ask about their medications. Programs such as Talk Before You Take (National Council on Patient Information and Education, 2016) encourage patients to communicate with healthcare providers about their medications. This public education effort was supported by the FDA and includes 10 key questions for patients to address, including what risks their medication poses to them. Successful countermeasures might be derived from improving similar education efforts to urge patients to specify that they need information regarding effects of their medication on driving performance.

Stressing enforcement. A recent literature review of traffic safety mass media campaigns suggested that these methods have high potential for effectiveness, although there may be individual differences among campaign messages. For example, studies showed high effectiveness at increasing seat-belt use and decreasing drunk driving for campaigns that stressed enforcement in particular (Wakefield, Loken, & Hornik, 2010). Although they have not been empirically evaluated thus far, mass media campaigns may see similar success in reducing prescription and OTC drugged driving. One example of an advertising campaign that stresses enforcement and consequences of prescription drug-impaired driving is displayed in Figure 4. This advertisement, from Ventura County Behavioral Health (2015), is part of a larger campaign to prevent drugged driving in Ventura County, California, and could be used as a model by other organizations.



Figure 4. Ventura County Behavioral Health advertisement alerting drivers to consequences of driving impaired by prescription drugs. From “IMPAIRED DRIVING: Prescription Drugs and Driving,” by Ventura County Behavioral Health, n.d., (<http://venturacountylimits.org/en/prevention/impaired-driving/prescription-drugs-and-driving>). Copyright 2018 by Ventura County Behavioral Health. Used with permission.

Increasing the visibility of law enforcement expertise may also have a positive result. For example, individuals may be less likely to drive under the influence of prescription and OTC substances if they are aware of the presence and expertise of DRE officers. Simply being aware of such law enforcement efforts to reduce drugged driving may have a significant impact on individuals’ intentions to drive. Armstrong, Watling, and Davey (2014) found that self-reported intentions to drive under the influence of drugs in Australia were lower if participants reported awareness of roadside oral-fluid drug-testing initiatives. Additionally, having avoided apprehension and knowing another person who had avoided apprehension for drugged driving was associated with increased self-reported intentions to drive under the influence of drugs, though the focus of this study was on illicit substances.

Prescription labeling. Although it has been described above, it is worth reiterating that messaging on prescription labels is also important. Finding a succinct way of effectively communicating driving risk could offer great potential for educating consumers and decreasing impaired driving from these medications.

Audience

The audience responding to education and advertising programs can range widely across several domains. Age may range from young teens seeking driver’s licenses to older adults seeking information about the risks associated with their prescriptions. Audiences to target were a central theme in the education and advertising countermeasure area. Experts stressed the importance of tailoring messages properly to each audience and suggested using message testing and focus groups to measure potential success of various programs for different audiences. Although there are few evaluations using message testing for

prescription and OTC drug-impaired driving prevention, there are several existing programs that aim to target a particular audience with this message.

Older Drivers. The AAAFTS conducted a survey of older adults (age 55 and older) and determined that only 27.6% were aware of potentially impairing medications' effects on driving. Further, only 17.6% had received a warning about impairing medications from a healthcare provider (MacLennan, Owsley, Rue & McGwin, 2009). Results were consistent even among those who were taking five or more prescriptions, highlighting the importance of targeting this group. A recent Australian study found similar results, in which older drivers were largely aware of impaired driving resulting from medical conditions, but were not knowledgeable in regards to effects of various medications on driving (Sargent-Cox, Windsor, Walker & Anstey, 2011). Recommendations emerging from these reports included increasing communication between healthcare providers and patients. Older drivers themselves should receive messages related to impairing medications, and healthcare providers should be alerted to their ability to serve as carriers of these messages for this population (which stands as another recommendation, discussed below).

There are a few education efforts designed to target older drivers. For example, AARP (2013) has included content on its website alerting drivers to check the effects of their medication before driving. Figure 5 displays another advertisement from Ventura County Behavioral Health (2015). One aim of the campaign was to target older drivers.



Figure 5. Ventura County Behavioral Health advertisement targeted to older drivers. From “IMPAIRED DRIVING: Prescription Drugs and Driving,” by Ventura County Behavioral Health, n.d., (<http://venturacountylimits.org/en/prevention/impaired-driving/prescription-drugs-and-driving>). Copyright 2018 by Ventura County Behavioral Health. Used with permission.

Experts in the interviews echoed the concerns that emerged in MacLennan et al. (2009). It is unclear whether messages such as that shown in Figure 5 reach many older drivers. This will likely depend on the medium (magazine, television commercial, mailer, etc.) by which the advertisement is distributed, as well as more specific factors. For example, interested parties should aim to advertise within specific magazines or television channels that are

matched to the demographic audience. Other strategies could include placing advertising directly at pharmacies or doctor's offices (where older drivers will inevitably be prior to obtaining their prescriptions) or at senior events. In terms of engaging older drivers in future research evaluating the effectiveness of education and advertising programs, NHTSA sponsored a report to investigate the best methods for evaluating driving while impaired by medications (Lococo & Staplin, 2006). This effort resulted in a recommendation of conducting research using a "brown-bag" approach, in which the older driver brings their medications to a pharmacy or other office to be assessed by a professional. This approach allows collection of data while appropriately considering both the confidentiality and accuracy of data. The project determined that confidentiality and the benefits of the research to society were particularly important to address when enrolling older drivers in studies. The project also identified medications that would be more relevant to older drivers, including blood pressure medications, benzodiazepines and other sedatives, tricyclic antidepressants, opioids, and medications affecting blood sugar.

Training can be provided to older drivers to educate them on how to self-screen for driver impairment. Such a program was developed by Eby, Molnar, Kartje, St. Louis, Parow, Vivoda, and Neumeyer (2008) with funding from NHTSA (SAFER Driving: The Enhanced Driving Decisions Workbook). This program is available online to older drivers and has received positive feedback from older drivers who participated, who particularly noted that their awareness of the issues surrounding medical conditions, medications, and driving increased (Molnar, Eby, Kartje, & St. Louis, 2010). However, it is unknown what effect this program has on actual impaired driving behaviors beyond increased awareness.

Family members. Experts suggested that educating family members about the risks of taking prescription and OTC drugs could be helpful for decreasing impaired driving by older family members. Experts were concerned that many family members may be unaware of the substances their family members are taking and their potential effects on driving. Another concern was the lack of communication between adults and teens. Parents may view conversations on drunk driving as necessary and important, but may not consider the various substances that teens are at risk for using or that may cause driving impairment. For example, cough syrups, decongestants, and antihistamines are all available to individuals younger than 21 years of age, meaning that they can be easier to obtain than alcohol for many teens. Experts also mentioned the importance of discussing prescription drugs that may be provided to teens following common procedures, such as removal of wisdom teeth. Parents should be coached in the dangers of driving under the influence of these drugs as well as strategies to limit teens' access to them, and should discuss responsible use of impairing medications with their teens.

Youth. While many youth programs comprehensively address driving under the influence of alcohol or even marijuana, few include prescription and OTC drugs. LifeSkills® Training incorporates prescription and OTC drug abuse in one of its training modules (National Health Promotion Associates, 2017). A different LifeSkills® program module on preventing general drug abuse decreased the likelihood of risky driving in teens, as measured by fewer points and violations on the driving records of teens who completed the program (Griffin,

Botvin, & Nichols, 2004). However, outcomes related to the module covering prescription and OTC drug abuse have not been studied.

Similarly, Young (1991) evaluated the “Alcohol, Drugs, Driving, and You” program for youth, finding that it showed promising results, including less willingness to ride with an impaired driver for those who completed the program. Individuals who completed the program also scored higher on knowledge assessments of impaired driving. Though the program did not address prescription or OTC drugs alone, it did include some content on this topic (The Change Companies, 2017).

A program by Above the Influence called “D. Driver” is a component of a larger community awareness toolkit that allows teens to experience simulated impairment under different drugs while driving in a video game. One scenario includes the influence of over-the-counter drugs on driving. The larger toolkit contains other components, such as teen panel discussions and printable posters. Unfortunately, the complete toolkit is no longer available online for download. However, the main guide is available online and can be customized by organizers (Office of National Drug Control Policy, 2017). Thus far, there have been no empirical studies on D. Driver or the larger toolkit.

Advertising directed at youth should be carefully planned and tested. An evaluation of a television advertisement in Scotland revealed that the majority of participants remembered seeing the advertisement targeted to young drivers. However, young participants expressed skepticism about the level of enforcement and noted the lack of relatable characters (Ormston, 2003). This advertisement and subsequent research was not solely focused on prescription or OTC drug use, but highlights both the importance of message testing as well as factors to consider in message design when targeting youth.

Prosecutors, judges, and court personnel. Expert interviewees were asked to cite what they believed were the largest challenges or barriers to countermeasures that would prevent prescription and OTC drugged driving. One of the most commonly cited responses was training for prosecutors, judges, and other court personnel. “A drug-impaired driving case can be complex and take up a lot of the prosecutor’s time. As a result, prosecutors don’t always get an opportunity to do a lot of these cases, and unless they have specialized training, it can be difficult. Sometimes prosecutors don’t devote as much training and education because they don’t do them as often, so when one comes along they may not have the best tools to get it done. The same goes for the judiciary. We have to train our judges to understand what the issues are in these drugged driving cases,” said Maine’s Traffic Safety Resource Prosecutor Scot Mattox.

Toxicologist Joseph Jones also discussed the importance of prosecutor and judge training, noting a barrier associated with getting convictions in impaired driving cases when prescription or OTC drugs are involved. Many prosecutors are reluctant to try these cases, and they are often thrown out due to the belief that the legal use of a substance, particularly one prescribed by a doctor, does not count as illegal behavior even when impairing driving. Many states are beginning to develop training programs and materials in this area.

Pharmacists and healthcare professionals. Pharmacists, doctors, and other healthcare professionals are crucial for relaying information to drivers about the risks of their medications. Hill, Rybar, and Styer (2013) conducted an evaluation of a program designed to increase health professionals' awareness of the importance of assessing medical issues that could result in driving impairment for older adults (including the use of prescription and OTC drugs). Prior to the intervention, few healthcare professionals reported that they frequently screened older adults for driving ability. Following the training, participants reported that the program increased their awareness of potentially impairing medications and of mandated reporting laws that existed in California, where the study was conducted. Although Hill et al. (2013) evaluated the program based on self-reports, their study showed that education for healthcare professionals may result in increased screening for driver impairments and a knowledge of the importance of this practice.

Barriers and Limitations. Because there is a lack of empirical research in this area, the vast majority of the countermeasures listed emerged from the recommendations of experts who participated in the roundtable and interviews. Targeted searches were completed for existing programs that aligned with these recommendations, but again, due to the lack of existing research it was not possible to determine whether these programs are effective within the scope of the present report. Although programs have been implemented, experimental techniques such as random assignment have not been used to control which individuals are exposed to them. Recording which individuals were exposed to these programs does not completely ameliorate this problem. For example, outcomes for states with education programs implemented within their DMV offices cannot be compared to those without such programs because other state-specific factors may influence the prevalence of prescription and OTC drugged driving. Future studies using more comprehensive analyses of these programs could utilize advanced statistical modeling to partially overcome this barrier, or could use experimental techniques that would allow stronger claims regarding effectiveness. Thus, a next step in the search for effective countermeasures lies in conducting empirical evaluations of education programs and advertising campaigns, which were the most highly recommended and valued interventions identified by experts in the current project. Overall, the vast majority of experts stressed a dire need for increased awareness of the issues surrounding prescription and OTC drugged driving.

Conclusion

This research examined countermeasures against OTC and prescription drug-impaired driving. While much is known about countermeasures against alcohol-impaired driving and, to a lesser extent, illicit drug-impaired driving (e.g., driving under the influence of cannabis), there is a significant research gap on countermeasures against driving while impaired by prescription and OTC drugs. This study sought to address this gap by conducting a comprehensive literature review, supplemented by an expert roundtable and expert interviews. Thus, this effort examined the current state of knowledge on countermeasures against prescription and OTC drug-impaired driving, examined evidence-based countermeasures, identified promising practices, and determined areas in need of further research.

The team examined more than 16,000 unique research records to comprehensively identify literature in this domain. This resulted in carefully reviewing more than 200 articles on countermeasures against OTC and prescription drug-impaired driving. While this research produced a strong basis for identifying a range of countermeasures, it also highlighted some prominent research weaknesses. Proper evaluations that included appropriate control groups, research design, statistical analysis, and other research best practices were uncommon. Thus, one of the largest findings of the present effort is that greater research and attention is needed in this area. The current report focuses on the existing research and opinions of experts across a wide range of critical professions for countermeasure development, research, and implementation. This provided a wealth of knowledge to make recommendations, but future research on specific countermeasures will be critical to making progress in this area.

This concluding section provides an overview of key takeaways from the research (not in order of priority). It highlights critical topics that emerged, key areas for research development, and promising countermeasures that offer the potential to save lives.

Better Information on Effects of OTC and Prescription Drugs

A common theme throughout the research was that little is known about the impairing effects of prescription and OTC drugs on driving. In many ways, this results from the complexity of understanding the effects of drugs other than alcohol. For decades, impaired driving research has centered around the effects of alcohol on driving. Clearly, alcohol-impaired driving is an important and complex topic. However, alcohol may serve as a poor model for understanding drug-impaired driving. Compared to other drugs, alcohol has a relatively consistent effect across individuals, the relationship between BAC levels and impairment is well understood, and measured BAC is directly related to the degree of impairment.

The complexity and lack of fundamental knowledge on the effects of many drugs on driving creates significant challenges. Furthermore, it may not even be possible to fully understand the relationships between drugs and driving performance because of the widely varying

effects a specific drug can have on an individual. Yet, this knowledge is often a critical first step for developing countermeasures. Targeting specific drugs for countermeasures and identifying safer alternatives requires understanding the effects of these drugs on driving performance. It also impacts the development of countermeasures. For example, it is challenging for a pharmacist to educate a patient about the potentially impairing effects of a medication if there is insufficient research on how a drug impacts driving performance. Similarly, it is difficult to implement an effective education or advertising campaign if there is not reliable scientific knowledge to inform the content of the campaigns.

While this knowledge can and should be generated for drugs other than alcohol, the complexity of drug pharmacokinetics and pharmacodynamics adds significant challenges compared to alcohol. Yet, the development of this knowledge is critical to developing, implementing, and appropriately targeting countermeasures for maximum effectiveness.

Misconceptions of Prescription and OTC Drug-Impaired Drivers

Public perception is another area where alcohol-impaired driving may not serve as an ideal example. It is believed that drunk drivers should know better. The risks of drunk driving and risk mitigation strategies such as using designated drivers or ridesharing programs are common knowledge. Drunk drivers are seen as individuals making a poor choice that results in significant harm and loss of life each year. It is relatively easy to negatively view drunk drivers and feel comfortable with harsh sentences for those convicted of drunk driving.

Regardless of one's perception of alcohol-impaired drivers, the issues of prescription and OTC drug-impaired drivers are much more complex. As noted above, millions of Americans take prescription and OTC medications each year to address health conditions. The use of these drugs may be necessary for quality of life or even life itself. Yet, millions of legal prescription and OTC drug users rely on driving to achieve productivity and quality of life. Many of these individuals are uninformed about driving risks. It is an understandable, albeit incorrect, assumption that taking a legally doctor-prescribed medication would not increase your crash risk or end in an impaired driving arrest. If this were the case, one would reasonably assume that a doctor, pharmacist, relative, or friend would warn the individual about the risks. Unfortunately, that often does not happen. Well-intentioned people end up behind the wheel when they are impaired by legally obtained medications.

It should also be recognized that some OTC and prescription medications may actually improve driving. For example, caffeine or stimulants may improve driving performance under some conditions. In other instances, taking a medication may help mitigate driving risks resulting from a medical condition or disease (e.g., a driver taking an antipsychotic medication for hallucinations). A common example would be a younger driver with attention-deficit/hyperactivity disorder (ADHD) who is taking a stimulant for treatment. There is some research evidence indicating a young driver diagnosed with ADHD may be safer when taking a prescribed medication (even when it is a non-stimulant) than without a drug treatment (Jerome, Segal, & Habinski, 2006).

The success of countermeasures in this domain requires understanding the nature of prescription and OTC drug-impaired driving. These drivers are often not ill-intentioned people who are knowingly placing themselves and others at risk of harm. They are often individuals who are taking legally obtained medications, as directed by a doctor, who rely on driving as their primary form of transportation. They are friends, family, neighbors, and colleagues. They are not people to be demonized, but often loved ones who need to be educated on the potentially impairing effects of their drugs.

Of course, there are abusers of prescription and OTC medications. In these instances, there is a separate set of countermeasures that are necessary to stop impaired driving by these individuals. However, attention must also be given to countermeasures designed to educate the general, medication-taking public about the risks of these drugs' effects on driving.

Polypharmacy

Another challenge identified through the research is the lack of research about and appreciation for polypharmacy and polydrug usage. If little is known about the effects of a single drug on driving performance, then significantly less is known about the effects of combinations of drugs. Polydrug usage is not only understudied but may represent a plurality of impaired driving cases. Unfortunately, due to the data limitations detailed in the report, the prevalence of polydrug usage remains largely unknown.

When polydrug usage is specifically examined in research it is often treated as a homogenous drug class. This means that polydrug users are considered as one group and compared to users of single drugs (e.g., only marijuana in their system). However, there are tremendous differences in polydrug usage that make these analyses imprecise. If the impairing effects of individual drugs vary greatly, adding various combinations of drugs would only make the impairing effects increasingly complex. Yet, all of these complexities are often combined into a single category for analysis. This is usually not done because of researcher ignorance of these complex effects, but rather because the sample size of specific drug combinations is often too small for separate analyses.

Furthermore, combinations of drugs can change the impairing effects of the drugs. Drug interactions can be classified in a number of ways, but usually fall into the categories of antagonistic, additive, and synergistic. Antagonism refers to the phenomenon when one drug reduces or blocks the effects of another drug. Additive refers to the effect of two substances acting in combination to produce an effect equal to the sum of both effects. Synergism occurs when the combination of drugs produces an effect larger than would be experienced by either drug alone, or larger than the additively combined effects of each drug (e.g., $1 + 1 = 3$). Other important factors are potentiation and interaction with metabolism. Potentiation refers to one drug increasing the effects of another drug by increasing the levels of the drug in the blood. Drugs can also interact with an individual's metabolism to increase or decrease another drug's effects.

These drug-drug interactions are classified as pharmacodynamic or pharmacokinetic. Pharmacodynamic interactions are those in which drugs directly influence each other's effects. For example, a drug may block a receptor, which then prevents another drug from

exerting effects at that receptor. Pharmacokinetic interactions involve reciprocal influencing of absorption, distribution, metabolization, and elimination, which impact drug concentrations. For example, a drug can inhibit enzymes involved in the metabolism of another drug, thus reducing the rate at which the drug is eliminated.

The issue is further complicated because of individual differences and interactions that are due to disease or food. Thus, understanding prescription and OTC drug-impaired driving necessitates understanding polypharmacy. As discussed below, this is particularly important for older drivers who may be prescribed numerous medications.

Aging Drivers

While the risk for OTC and prescription drug-impaired driving exists across the population, this concern is particularly salient for older drivers. These drivers are not only more likely to be taking medications but are more likely to be taking multiple medications. Additionally, medication usage is only one important aspect of the broader considerations related to fitness to drive.

The likely increased risk of OTC, and to a greater extent, prescription drug-impaired driving should foster the development of countermeasures specifically targeted to this population of aging drivers. As one example, in the AAA Foundation for Traffic Safety study on community dwelling drivers 55 years and older, only 21.9% of individuals taking five or more potentially driver impairing medications reported some awareness of the impairing effects of these medications, and only 18.8% reported receiving a warning about the impairment risks (MacLennan et al., 2009). This is a disheartening finding, but it also points to one area where a countermeasure could be highly effective. Specifically, education targeted towards seniors from medical professionals, family members, or relevant news outlets and magazines could address this significant awareness gap.

Patient Counseling

A major finding from this research is that many individuals do not receive adequate counseling from a trained medical professional. This could include a physician, nurse, doctor, psychologist, psychiatrist, or pharmacist. Considering the lack of awareness about the impairment potential of many prescription and OTC medications, this counseling would likely produce important safety benefits.

It became clear in the expert roundtable that this type of patient counseling was highly valued and included in most medical curriculum. In particular, the pharmacists on the panel mentioned that most pharmacists would be highly trained on the delivery of patient counseling related to potentially impairing medications and polypharmacy drug interactions. Yet, the experts acknowledged this type of personal and detailed patient counseling is rare.

It emerged from these experts that despite a good training curriculum in this area, there are significant barriers that are difficult to overcome. Most importantly, time with a patient

is a valuable resource that is in short supply in today's medical climate. There is growing pressure to treat patients quickly and see more patients over the same period of time. These pressures arise from the specific medical facility and leadership but also from insurance companies. However, it was also mentioned that patients may also be unhappy with the extra time it would take to receive information on the potential side effects of their medications. This could result in lower patient ratings, which would also be extremely detrimental to one's medical career or practice. All of these factors are directly tied to financial incentives and cost cutting.

Yet, it is one of the highest duties of the medical professional to do no harm and help patients. This undoubtedly encompasses advising patients of driving risks related to their prescribed medications. This could include a standard patient intake question asking about driving behavior or asking a patient to be aware of the risks of driving under their prescribed medications. If patient counseling is already a critical piece of many medical curriculums, then the focus should be on greater implementation. There must be ways to not only treat patient counseling as a value but also as an obligation. It is something necessary that is worth the extra time. Incentives for proper patient counseling should be considered to counteract the financial barriers observed by many medical professionals.

Environmental strategies should also be enacted. This could include simply adding a driving question to patient intake forms. It could also include implementing an electronic system that notifies pharmacists of medication side effects related to safe driving. Each of these environmental changes would help create a consistent structure conducive to providing important information while respecting the time needs of medical professionals.

Prescription Labeling

One of the most common themes from the multiple data sources examined for this research related to prescription labeling. There was a relatively large body of research in this area (albeit mostly self-report and perception-based) and multiple experts discussed the need for improvements in prescription labeling in the United States. A classic example was that many Americans simply do not understand the potentially impairing effects of medications based on the labeling and do not realize the warning to "not operate heavy machinery" applies to their personal vehicle. The majority of experts consulted for this project did not feel the current labeling adequately conveyed driving risk to the average medication consumer. This is a clear problem when these consumers are also not receiving driving warnings from doctors, nurses, psychologists, or pharmacists.

Certainly, drastic improvements could be made in prescription labeling. This could include changing the color of labeling to denote a driving warning. For example, Hill et al., 2013 added color- and symbol-specific labels to sleep aids, heart medications, and others. A similar approach could be followed with drugs that impair driving. Other recommendations included introducing a minimum font size, which would be particularly helpful for older individuals. These approaches are supported by existing science in this area. An innovative idea from the expert interviews was changing the actual color of the prescription bottle to denote potentially impairing effects. This would create a strong visual indicator that a drug

may potentially be impairing. For example, potentially impairing drugs could be prescribed in a purple pill canister.

These changes would not come without challenges. Variance exists in how drugs are labeled and how drug pamphlets are designed based on the pharmacy. Significant changes would require coordination across the pharmaceutical industry. However, these changes could also result in reductions in harm from impaired driving. Improving labeling also acknowledges that an important subset of impaired drivers do not realize the drugs they are taking could produce driver impairment. New labeling practices could improve awareness and prevent well-intentioned individuals from making dangerous driving decisions.

Developing and Implementing Innovative Technological Solutions

Another countermeasure involved developing and leveraging innovative technologies – particularly for drug detection. This would have a particular benefit for law enforcement. Another area where alcohol impaired driving is greatly disconnected from drugged driving relates to the detection of drug presence. There is no “breathalyzer” for drugs that can provide quick and precise drug concentration readings without invasive procedures. While some technologies are being developed and piloted (particularly for THC), such technologies are likely not immediately forthcoming.

This does not mean advancements in drug testing do not exist. One area of growing promise is the usage of oral fluid for drug testing. Indeed, research has demonstrated that oral fluid and blood samples provide similar information on recent drug usage (Kelley-Baker et al., 2014). Typically, these oral fluid samples are collected and sent for laboratory analysis. However, roadside devices are on the market that can quickly detect the presence (positive versus negative) of a small panel of drugs. This could be invaluable for law enforcement when making an arrest decision or calling a trained ARIDE officer or DRE. There are a number of studies sponsored by NHTSA and various states to examine the accuracy of these roadside oral test devices. As one example, the state of Michigan recently passed legislation authorizing a study of the accuracy of roadside oral testing devices.

Innovations must also occur in the behavioral detection of drug-impaired individuals. This is best highlighted by the rapidly growing DEC program. The report provides a number of ways that the DEC program can be streamlined to better serve its underlying goal of quickly and accurately identifying drug-impaired drivers. Research should continue to examine ways to improve the efficiency of the program. This could include reducing the average amount of time it takes to conduct the evaluation and continuing to evaluate the accuracy of various steps in the evaluation.

Efforts need to be made to continue technological innovation in this area. This includes developing new drug detection technologies, validating emerging technologies, and streamlining existing processes.

Synergy Across the Legal System

The classic Driving While Intoxicated (DWI) playbook does not directly translate to drugs other than alcohol. In fact, the legal picture is significantly more complicated. As noted above: there is little accurate research behind per se limits for various drugs (unlike .08% for alcohol); officers are more likely to be trained and qualified in Standardized Field Sobriety Tests as compared to drug detection; the drug toxicology is complex; prosecutors may be unfamiliar with drugged driving cases; and judges and jury members have much less familiarity with handling drugged driving compared to alcohol-impaired driving.

The reality is that while imperfect, the alcohol-impaired driving legal process is relatively consistent and well established. A police officer conducts the three SFSTs and obtains a sample for the BAC. If the individual scores poorly on the SFSTs and has a BAC over the per se legal limit, then there is a high likelihood of getting a conviction. This is not the case for drug-impaired driving. The extra complexity and lack of training requires cooperation and coordination across all members of the legal system (e.g., law enforcement, toxicology, prosecutors, and judges). It should be noted that this cooperation, proper protocol, and training is designed to not only result in a conviction for a drug-impaired driver, but also to ensure wrongful convictions do not occur.

Whereas a BAC reading provides significant information about alcohol-impaired driving, no such meaningful number exists for drug-impaired driving. This results in the need to carefully collect information from a variety of legal personnel. This starts with a police officer who needs to carefully observe the signs of driving impairment that led to making the initial decision to pull a driver over. The officer must document signs of impairment and, if needed, receive support from an ARIDE-trained officer or DRE. A biological sample must quickly be taken and provided to a toxicologist for analysis. Unlike alcohol, the results of this drug test will not indicate any level of impairment. Yet, the combination of officer observations and toxicology results will begin to tell a story about the ability of an individual to operate a vehicle. The prosecutor must understand the strengths of available evidence as well as the weaknesses of available evidence (e.g., not asking the toxicologist to make observations about impairment from the drug test results). A judge must then be educated about the quality of the DRE process and how evidence fits together to show impaired driving. As can be seen from this example, prosecuting drugged driving offenses is about telling a coherent story from multiple sources of data. This requires proper training from numerous individuals on an impaired driving case and synergy amongst these individuals of varying backgrounds.

Countermeasures that can provide training and education that improves this process and promotes synergy among these individuals are highly valuable at reducing impaired driving. The legal process, including police arrests, is one of the most important countermeasures for removing individuals who are driving impaired from our nation's roadways before they can hurt themselves or others.

Improved Data Systems

Data systems are necessary to track the problem of drugged driving and assess countermeasures. Unfortunately, despite the greater attention being given to drugged driving, most state data systems are highly limited at tracking arrests, crashes, injuries, or fatalities resulting from drugged driving (see Arnold & Scopatz, 2016, a discussion of barriers and countermeasures). There are a number of barriers and limitations to these data systems that must be improved.

One of the largest challenges is linking these data across multiple databases and data systems. For example, there are numerous databases that would need to be linked to track an individual from the time of arrest to the final disposition of a case. This may include arrest records, crash records, traffic records, DRE evaluations, toxicology reports, and court documents. States must continue to evolve better data linking procedures and systems to provide suitable data on drugged driving.

It is also critical to standardize toxicological data. This includes identifying common procedures, drug panels, cutoff scores, and reporting. This will not only improve the quality of toxicological data, but it will provide standardization across toxicology labs on critical variables. Ultimately, this may enable comparisons across labs that are currently impossible due to inconsistencies in lab equipment, procedures, and reporting.

Thus, a critical countermeasure is improving databases through standardized procedures and better data linking. States serve as a primary target for improving these data. The improvement of these data can lead to better tracking of impaired driving problems and serve as a tool for better research on the effectiveness of countermeasures.

Increased Attention and Resources

Across all countermeasures, a common barrier is a lack of attention and resources. Likely as a result of marijuana legalization, increased attention has recently been given to the topic of drug-impaired driving. However, this attention is often focused on driving under the influence of cannabis or illicit drugs. Prescription and OTC drug-impaired driving remains as a critical topic in need of greater awareness and recognition. The prevalence of prescription and OTC drug usage, number of drivers taking these drugs, and significant public health consequences that result from impaired driving, necessitate a dedicated focus on this topic.

This report systematically identified existing literature and expert opinions on countermeasures against prescription and OTC drug-impaired driving. The lack of rigorous empirical research in this area should encourage researchers, funding agencies, and the public to pay greater attention to this topic. This should include additional research on the effects of various drugs on driving performance, as well as evaluation studies of drugged driving interventions.

Despite the limited scientific literature, promising countermeasures emerged from this research. These countermeasures offer the potential to educate consumers about the risks

of prescription and OTC drugs, as well as remove impaired drivers from our nation's roadways. This report offers a comprehensive review of the topic and identifies opportunities for saving lives through effective countermeasures.

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Appendix A: Search Strategy and Key Terms

Drug Terms	Driving Terms	Effect Terms	Solution Terms
6-acetylmorphine	Automobile	Adverse*	Adverse drug reporting
Alprazolam	Drive*	Affective disorder	Advertising
Amitriptyline	Driving under the influence*	Agnosia	Arrest
Amphetamine	Driving while impaired	Amblyopia	Campaign
Anticonvuls*	Driving while intoxicated	Anticholinergic syndrome	Countermeas*
Antihistamine*	DUI	Asthenopia	Drug approval
Antipsychotic*	DUID	Ataxia	Drug monitoring
Azelastine	DWI	Attentional blink	Drug utilization review
Barbiturate*	Operating a vehicle while intoxicated	Biological control agents	Education
Benzodiazep*	OVI	Blurr*	Enforcement
Brompheniramine	Vehicle	Chemically induced	Government program
Butalbital		Chemically-induced disorder	Harm reduction
Carisoprodol		Cognitive dysfunction	Health communication
Cetirizine		Complication	Health educators
Chlordiazepoxide		Dizz*	Incarceration
Chlorpheniramine		Drows*	Intervention
Citalopram/escitalopram		Drug effect*	Jail
Clemastine		Drug induced	Labeling
Clonazepam/7-aminoclonazepam		Drug interaction	Labelling
Codeine		Drug tolerance	Legislation
Cyclobenzaprine		Executive function	Mandatory program
Desipramine		Fatigue	Marketing
Desloratadine		Harm	Medication therapy management
Dexmethylphenidate		Hypersensitivity	Medication therapy review
Dextroamphetamine		Impair*	Medication therapy service*
Dextromethorphan		Irritability	National health program

Drug Terms	Driving Terms	Effect Terms	Solution Terms
Diazepam/nordiazepam		Lethargy	Patient care planning
Diphenhydramine		Maximum allowable concentration	Patient consultation*
Doxepin		Medical error	Penalt*
Doxylamine		Memory disorders	Pharmacist consultation*
Drug*		Motor skills disorders	Pharmacist intervention*
Fentanyl		Nausea	Pharmacoepidemiology
Fexofenadine		Near miss	Pharmacovigilance
Fluoxetine		Neurobehavioral manifestations	Pharmacy intervention*
Histamine*		Nocebo effect	Police
Hydrocodone		Parasomnias	Policy
Hydromorphone		Poison	Post marketing surveillance
Hypnotic*		Postmarketing	Postmarketing surveillance
Imipramine		Product surveillance	Program*
Intoxic*		Psychomotor disorder	Prosecution
Ketamine		Safety	Public service announcement
Levocetirizine		Serotonin syndrome	Punishment
Lisdexamfetamine		Side effect*	Risk assessment
Loratadine		Sleep initiation disorder	Risk management
Lorazepam		Sleep*	Safety management
Medicat*		Tired	Safety-based drug withdrawals
Meperidine		Tolerable	Sentencing
Meprobamate		Toxicity	Strateg*
Methadone		Vertigo	Toxicogenetics
Methamphetamine		Vision disorder	Toxicology
Methylphenidate			Voluntary program
Morphine			
Muscle relaxant			
Muscle relaxer			
Norfluoxetine			
Norsertaline			
Nortriptyline			

Drug Terms	Driving Terms	Effect Terms	Solution Terms
Norvenlafaxine			
Olanzapine			
Opioid			
OTC			
Over the counter			
Over-the-counter			
Oxazepam			
Oxycodone			
Oxymetazoline			
Oxymorphone			
Phenobarbital			
Phenylephrine			
Prescription			
Propoxyphene			
Propranolol			
Pseudoephedrine			
Sertraline			
Stimulant*			
Tapentadol			
Temazepam			
Topiramate			
Venlafaxine			
Zolpidem			

Appendix B: Expert Roundtable Agenda



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Countermeasures for Over-the-Counter and Prescription Drug-Impaired Driving

Discussion Guide

- **9:00am: Introduction and Overview by AAAFTS & VTTI**
- **9:30am: Expert Roundtable Discussion**
 - **9:30 – 10:30am: Pharmacy/Medical**
 - Duty to Warn/Patient Counseling
 - Prescription Labeling Practices (e.g., factors that increase comprehension)
 - **10:30 – 11:30am: Data Recording and Toxicology**
 - Biological Drug Detection
 - Field Sobriety Tests
 - Employment Testing
 - Comprehensive, Standardized, and Linkable Datasets
 - **11:30am – 12:30pm: Law Enforcement and Court Efforts**
 - DRE and ARIDE Training
 - DUI/Drug Courts
- **12:30pm – 1:30pm: Lunch On-Site**
 - **1:30pm – 2:30pm: Educational Programs and Advertising**
 - State and National Initiatives
 - New Media Opportunities
 - Youth
 - New Drivers
 - Commercial Motor Vehicle Drivers
 - **2:30pm – 3:30pm: Additional Special Concerns for Older Drivers**
 - Polypharmacy
 - Non-Drug and Drug Impairment Interactions
- **3:30pm: Closing Remarks by AAAFTS & VTTI**

VTTI: Advancing Transportation through Innovation

AAAFTS: Saving Lives through Research and Education

Appendix C: Expert Interview Questionnaire

We are going to ask you a series of questions about the following four categories of countermeasures: Pharmacy and Medical, Data Recording and Toxicology, Law Enforcement and Court Efforts, and Educational Programs and Advertising. We will have several questions within each of these categories. Feel free to share opinions across all countermeasures, and we understand you may have more or less experience in certain areas. Regardless of your direct experience in a given area, we believe your background gives you a unique perspective on effective countermeasures. Do not feel like you need to have directly worked with a particular countermeasure or category of countermeasure to share your opinion. Keep in mind that you are not required to respond to any questions where you do not feel comfortable providing a response. Do you have any questions before we begin?

1. To begin, could you briefly describe your current position?
2. Have you implemented any countermeasures or do you have any direct experiences with specific programs that you would like to discuss?
3. Our first set of questions asks about pharmacy/medical-based countermeasures. This could include better prescription labeling or a pharmacist's duty to warn a patient about the risks of prescription drug-impaired driving. Again, as we go through these categories feel free to provide opinions or skip a question.
 - 3a. Do you have any experience with countermeasures in this area? If yes, which programs have you worked with?
 - 3b. What do you see as the biggest challenges or barriers for countermeasures in this area?
 - 3c. Do you have any suggestions for specific countermeasures in this area? (If yes, follow-up questions will examine the feasibility, efficacy, barriers, and modifications to the suggested countermeasures.)
 - 3d. Are there any other areas you would like to discuss in relation to pharmacy/medical countermeasures?
4. Our next set of questions asks about data recording and toxicology countermeasures. This could include standardizing toxicology practices for drugs following a fatal crash or better electronic record keeping of medical prescription records.
 - 4a. Do you have any experience with countermeasures in this area? If yes, which programs have you worked with?
 - 4b. What do you see as the biggest challenges or barriers for countermeasures in this area?
 - 4c. Do you have any suggestions for specific countermeasures in this area? (If yes, follow-up questions will examine the feasibility, efficacy, barriers, and modifications to the suggested countermeasures.)

- 4d. Are there any other areas you would like to discuss in relation to data recording and toxicology countermeasures?
5. Our next set of questions asks about law enforcement and court-based countermeasures. This could include increasing the number of police officers with DRE or ARIDE training, developing behavioral tests for detecting over-the-counter and prescription drugs, and prosecutor training for handling these types of impaired driving cases.
- 5a. Do you have any experience with countermeasures in this area? If yes, which programs have you worked with?
- 5b. What do you see as the biggest challenges or barriers for countermeasures in this area?
- 5c. Do you have any suggestions for specific countermeasures in this area? (If yes, follow-up questions will examine the feasibility, efficacy, barriers, and modifications to the suggested countermeasures.)
- 5d. Are there any other areas you would like to discuss in relation to law enforcement and court-based countermeasures?
6. Our final set of questions asks about education and advertising-based countermeasures. This could include creating media toolkits for states to implement effective media campaigns related to over-the-counter and prescription drug-impaired driving, increasing federal-agency sponsored education programs, or including segments on over-the-counter and prescription drug-impaired driving in driver's education classes.
- 6a. Do you have any experience with countermeasures in this area? If yes, which programs have you worked with?
- 6b. What do you see as the biggest challenges or barriers for countermeasures in this area?
- 6c. Do you have any suggestions for specific countermeasures in this area? (If yes, follow-up questions will examine the feasibility, efficacy, barriers, and modifications to the suggested countermeasures.)
- 6d. Are there any other areas you would like to discuss in relation to education and advertising-based countermeasures?
7. What do you believe are the biggest challenges to preventing over-the-counter and prescription drug-impaired driving?
8. Do you have any other comments you would like to share with us today?

Thank you so much for sharing your experience and opinions with us today. Please let us know if you have any questions or if you would like to share any further information. We hope you enjoy the rest of your day.

Appendix D: Expert Roundtable Countermeasure Ratings

Countermeasure ratings that emerged during the expert roundtable

Countermeasures were rated along two dimensions: effectiveness and feasibility. Along both dimensions, the rating scale ranged from one to five. A score of one indicated “Not at All,” effective or feasible and a score of five indicated “Highly” effective or feasible. Scores of three indicated “moderately” effective or feasible. After scores were tabulated for both dimensions, each pair of scores was multiplied to obtain a combined score (Effectiveness X Feasibility) for each countermeasure.

Top Five Countermeasures			
Countermeasure	Effectiveness Mean (SD)	Feasibility Mean (SD)	Summary Score Mean (Effectiveness X Feasibility) (SD)
1. Follow DRE best practices	4.20 (0.92)	3.80 (0.79)	16.30 (5.70)
2. Include a symbol/graphic on the prescription label (move toward European style)	4.45 (0.50)	3.60 (1.17)	16.25 (6.07)
3. Include segments on prescription and OTC drug use in driver’s education classes	3.80 (1.19)	4.00 (0.76)	15.70 (7.10)
4. Increase federal-agency sponsored education programs	3.80 (1.16)	3.90 (0.83)	15.60 (7.60)
5. Increase education on polypharmacy and combinations with alcohol	4.20 (0.64)	3.60 (1.19)	15.60 (6.43)

Patient Counseling			
Countermeasure	Effectiveness Mean (SD)	Feasibility Mean (SD)	Summary Score Mean (Effectiveness X Feasibility) (SD)
1. Ensure patient counseling by pharmacist or doctor	3.75 (0.79)	3.65 (0.47)	13.43 (1.82)
2. Include a question on patient intake forms about driving	3.60 (0.84)	3.50 (0.97)	12.70 (4.92)
3. Standardize patient intake forms	3.80 (0.79)	3.10 (1.29)	12.20 (5.90)
4. Improve system to encourage disposal of unused medication	3.00 (1.32)	3.67 (1.12)	11.11 (5.64)
5. Increase manufacturer research on effects of medication on driving	3.40 (0.70)	3.00 (1.41)	10.30 (5.10)
6. Encourage pharmacist and patient interaction for OTC drugs	3.60 (0.97)	2.60 (0.70)	9.70 (4.45)
7. Revise pharmacist and doctor compensation practices to encourage patient counseling	3.80 (1.03)	2.20 (1.23)	8.50 (5.06)
8. Require coordination between agencies to ensure duty to warn	3.00 (0.94)	2.40 (0.97)	7.50 (3.89)

Medication Labeling			
Countermeasure	Effectiveness Mean (SD)	Feasibility Mean (SD)	Summary Score Mean (Effectiveness X Feasibility) (SD)
1. Include a symbol/graphic on the prescription label (move towards European style)	4.45 (0.50)	3.60 (1.17)	16.25 (6.07)
2. Require minimum font size	4.20 (0.63)	3.40 (1.17)	14.10 (4.61)
3. Put a sign on the shelf of OTC drugs	3.60 (0.84)	3.20 (1.14)	11.90 (4.84)

Data Recording and Toxicology			
Countermeasure	Effectiveness Mean (SD)	Feasibility Mean (SD)	Summary Score Mean (Effectiveness X Feasibility) (SD)
1. Standardize biological testing (cutoff values, protocols, and drugs)	4.10 (1.10)	2.90 (0.99)	15.17 (4.36)
2. Increase access to databases	4.20 (0.92)	2.70 (0.67)	12.83 (4.62)
3. Maintain prescription drug monitoring programs (PDMPs) and electronic medical records	4.00 (0.82)	3.00 (1.25)	12.33 (7.87)
4. Develop and validate behavioral tests for prescription and OTC drugs	4.30 (0.95)	2.67 (0.87)	10.50 (5.86)
5. Perform/improve behavioral tests for impairment	4.25 (0.79)	2.50 (0.61)	9.29 (5.63)
6. Mandate testing in all DWI arrests	3.80 (0.92)	2.30 (1.06)	8.67 (4.37)

Law Enforcement			
Countermeasure	Effectiveness Mean (SD)	Feasibility Mean (SD)	Summary Score Mean (Effectiveness X Feasibility) (SD)
1. Follow DRE best practices	4.20 (0.92)	3.80 (0.79)	16.30 (5.70)
2. Improve/increase behavioral testing	4.50 (0.79)	3.56 (0.53)	14.65 (6.43)
3. Require ARIDE training for all officers	4.40 (0.97)	2.75 (1.14)	12.45 (6.31)

Education and Advertising			
Countermeasure	Effectiveness Mean (SD)	Feasibility Mean (SD)	Summary Score Mean (Effectiveness X Feasibility) (SD)
1. Include segments on prescription and OTC drug use in driver's education classes	3.80 (1.19)	4.00 (0.76)	15.70 (7.10)
2. Increase federal-agency sponsored education programs	3.80 (1.16)	3.90 (0.83)	15.60 (7.60)
3. Increase education on polypharmacy and combinations with alcohol	4.20 (0.64)	3.60 (1.19)	15.60 (6.43)
4. Develop media toolkits for states to ensure standardization	3.90 (0.83)	3.80 (0.83)	15.30 (5.96)
5. Develop employer-sponsored programs (especially for occupations involving driving)	3.70 (1.04)	4.00 (0.64)	15.10 (5.61)
6. Distribute flyers at checkpoints and DMVs	3.40 (1.06)	3.90 (1.06)	13.80 (6.34)
7. Use message testing with the target audience	3.70 (1.16)	3.40 (0.93)	13.10 (5.99)
8. Educate through social media	3.10 (1.07)	3.90 (0.71)	12.60 (6.17)
9. Encourage family education	3.50 (1.20)	3.30 (1.07)	12.20 (7.07)
10. Create manufacturer-sponsored education programs	3.20 (0.74)	3.50 (1.19)	11.70 (6.31)
11. Educate public on the signs of impairment	3.50 (1.30)	3.20 (0.89)	11.50 (5.64)

Education and Advertising			
Countermeasure	Effectiveness Mean (SD)	Feasibility Mean (SD)	Summary Score Mean (Effectiveness X Feasibility) (SD)
12. Educate public to ask pharmacist and doctor for advice on driving with a prescription	3.2 (0.92)	3.40 (1.19)	11.40 (6.93)
13. Create automobile-insurance led education programs	3.90 (0.89)	2.70 (1.16)	11.00 (6.22)
14. Create graphic public service announcements	3.20 (1.16)	3.10 (1.28)	10.60 (7.06)
15. Develop community-led programs	3.20 (0.71)	3.10 (0.71)	10.10 (3.81)
16. Educate public on the impact of prescription and OTC drug use on brain development	2.70 (0.74)	2.70 (0.92)	8.00 (5.87)

Appendix E: ICADTS Prescribing and Dispensing Guidelines

ICADTS Prescribing and Dispensing Guidelines (Adapted from Alvarez et al., 2007).

Prescribing Guidelines	Dispensing Guidelines
1. Realize that the use of some psychoactive drugs has been associated with an increased risk of causing an injurious accident and that patients should receive this information.	1. Discuss with prescribing physicians what patient information (written and oral) should be provided at the first delivery of a particular impairing drug.
2. Consider an alternative in the light of experimental research showing large differences between the effects on driving performance of various drugs within the same therapeutic class.	2. Inform the prescribing physician that alternative drugs exist in case a drug in class II or III has been prescribed, and inform the patient.
3. Start with the lowest doses of psychoactive medical drugs and whenever possible avoid multiple dosing over the day.	3. Advise the physician to prescribe the lowest effective dose of a particular psychoactive medicinal drug and to avoid multiple dosing over the day. Inform the patient.
4. Do not reflexively "double the dose" if patients fail to respond to psychoactive medication.	4. Advise the physician to try another drug if the patient reports a lack of efficacy after beginning of treatment and inform the patient. If higher doses are needed advise the patient to use the largest part before sleep (if compatible with the therapeutic regimen).
5. Avoid prescribing different psychoactive drugs in combination.	5. Explain to the patient that polytherapy with psychoactive drugs is always an experiment with the patient's safety and to avoid driving if treatment cannot be adjusted.
6. Do not rely solely upon the manufacturer's advice for counseling patients about the effects of the drug upon driving.	6. Explain to the patient why warnings provided by the manufacturer about their drug's effects on driving are vague, illogical and sometimes misleading.
7. Advise patients concerning the ways they can minimize the risk of causing a traffic accident if it is impossible to avoid prescribing an obviously impairing drug or one with unknown impairing potential.	7. Advise the patient the ways they can minimize the risk of causing a traffic accident if they have to use a drug with an impairing potential.
8. Monitor the patient's driving experience with the drug.	8. Monitor the patient's driving experience with the drug (e.g., at the first refill) and report back to the physician or ask the patient to inform the physician.

Appendix F: Detection Limits used in Vindenes et al. (2011)

Detection limits used in Vindenes et al. (2011) for prescription drugs. Each column represents levels of impairment similar to 0.02, 0.05, and 0.12% blood alcohol concentration (BAC) in blood. All drug levels are quantities in ng/ml of whole blood.

Drug	Concentrations corresponding to impairment (0.02% BAC).	Concentrations corresponding to 0.05% BAC.	Concentrations corresponding to 0.12% BAC.
Benzodiazepines			
Alprazolam	3.0	6.0	15.0
Clonazepam	1.3	3.0	8.0
Diazepam	57.0	143.0	342.0
Fenazepam	1.8	5.0	10.0
Flunitrazepam	1.6	3.0	8.0
Nitrazepam	17.0	42.0	98.0
Oxazepam	172.0	430.0	860.0
Sleep Aids			
Zolpidem	31.0	77.0	184.0
Zopiclone	12.0	23.0	58.0
Stimulants			
Amphetamine	41.0	*	*
Methamphetamine	45.0	*	*
Opioids			
Buprenorphine	0.9	*	*
Methadone	25.0	*	*
Morphine	9.0	24.0	61.0

*not listed as established by research at time of publication